Patient characteristics related to health care consumption

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Towards a differentiated capitation model

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CHAPTER 1

GENERAL INTRODUCTION

GENERAL INTRODUCTION

Every country organizes health care in a different way. Different types of organization lead to different types of financing systems for health care. A wide range of financing systems for health care is used internationally. There are three common types of financing systems: the first is a budget or capitation financing, where all (or parts of) the health care provided is financed from a single budget. The second system is fee-for-service (FFS), where each healthcare item is financed separately. Third is a salary system, in which healthcare providers are paid a fixed amount of money per period of time that they are providing care. Each type of financing system in health care has advantages and disadvantages (Berenson, Rich 2010, Gosden et al. 2000).

A capitation system discourages the provision of many items of health care per patient, as it does not add additional financing for the provider. It can also lead to higher referral rates (Gosden et al. 2000, Gosden et al. 2001, Sorensen, Grytten 2003). On the other hand, a capitation system does not encourage the provision of unnecessary health care. An FFS system encourages provision of more items of healthcare service. It stimulates having more contact with patients and using more diagnostic and therapeutic service items. FFS can lead to higher continuity of care between patient and healthcare provider, lower referral rates and shorter waiting times (Liddy et al. 2014). In a salary system the patients appear to be most satisfied (Gosden et al. 2000, Pereira, Pearson 2001).

A differentiated capitation system provides a good alternative for the above-mentioned financing systems and their advantages and disadvantages. A differentiated capitation system possesses the advantages of a capitation system, but without one major disadvantage: an unfair capitation budget for a large group. Often the capitation budget is

either too high (for patients with low consumption of healthcare resources) or too low (for patients with high consumption rates). Although a differentiated capitation system provides one budget per patient per period of time, this budget is adjusted to specific characteristics of the patient. Characteristics that lead to adjustments to the capitation budget could be demographic (e.g. age, sex, marital status), health-related (e.g. comorbid illnesses) or lifestyle-related (e.g. smoking status, fitness level).

Although financing systems in health care can have a major impact on the care provided, there is only a small amount of literature available on this subject. Specifically for differentiated capitation models there is barely any scientific evidence. To enlarge the knowledge about differentiated capitation models, a starting point is to study which patient characteristics are usable in such models. These characteristics should enable differentiation between high and low healthcare consumption, given that the consumption of health care (i.e. the amount of care that a patient consumes during a period of time) is directly related to the budget needed to provide the care.

The aim of this thesis is to expand the knowledge about which patient characteristics are related to healthcare consumption that ultimately can be used in a differentiated capitation model. The main research question is:

Which patient characteristics are related to healthcare consumption, and to what extent are they related?

Health care provided in primary care is considerably different from health care in the hospital sector. It is to be expected that different patient characteristics will be related to the healthcare consumption in these two sectors, therefore the sub-questions derived from the main research question are:

1. *Which patient characteristics are related to healthcare consumption in the primary care sector in the Netherlands?*
2. *Which patient characteristics are related to healthcare consumption in the hospital sector in the Netherlands?*

These sub-questions will be introduced in the following sections.

PRIMARY HEALTH CARE SECTOR

The current financing system for the Dutch primary healthcare sector consists of both a capitation system and fee-for-service (FFS) (Dutch Health Care Authority. June 2012, Smolders, Seinen 2007). Every general practitioner (GP) with whom patients are enrolled receives a capitation fee on a quarterly basis every year. GPs can also receive an additional capitation reimbursement when they provide care for specific patient groups, for example patients with diabetes or asthma. For every item of care, for example a consultation or house call, the GP receives an additional fee (FFS). With such a mixed system of financing, the government tries to provide the best financial stimuli for GPs. On one hand this system should prevent overproduction due to the large capitation budget, on the other the system discourages unnecessary referrals as is the case for capitation systems only (Krasnik et al. 1990, Eggleston 2005). The mixed financing system of Dutch primary healthcare is however very complex. It incorporates many different financial components which together make up for the total reimbursement of the practice. The table below presents an overview of the sources of reimbursements for an average primary care practice and the percentage that it makes up of the total income.

Table 1. Sources of reimbursement of an average primary care practice in 2014 (Vektis 2014)

Reimbursement source	% of total income
Capitation for all patients	18%
Variable reimbursement for reaching specific targets	17%
Capitation fee and FFS for providing mental health care	14%
Consultations (FFS)	14%
Module POH-S* (capitation)	14%
Module POH-S* (FFS)	13%
Multidisciplinary care* (capitation)	4%
Out-of-hours services (FFS)	3%
Special procedures (e.g. surgery) (FFS)	2%

* providing health care for patients with diabetes mellitus, atrial fibrillation, chronic obstructive pulmonary disease, cardiovascular risk management and elderly care

A differentiated capitation model may alleviate this complex reimbursement system. The current system has incorporated two patient characteristics that differentiate the capitation budget. First, for patients aged over 65 years and over 75 years the GP receives a higher capitation budget. Second, for patients living in deprived areas the capitation budget is also higher (Duth Health Care Authority. June 2012). The scientific evidence that these patients have a higher healthcare consumption at the GP's office, which would support this system, is scarce though.

There is also very little evidence that other patient characteristics have a relation with healthcare consumption, such as other demographic characteristics like sex and marital status or characteristics related to patients' health, like comorbid illnesses (Rice et al. 2000, Dixon et al. 2011). Although the relation between healthcare consumption and patient

comorbidity has been widely studied in the hospital sector, this knowledge is lacking in the primary healthcare sector.

A disadvantage of a differentiated capitation system is that it could increase the number of referrals to the hospital sector, as is the case for capitation systems without differentiation (Gosden et al. 2000, Gosden et al. 2001, Sorensen, Grytten 2003). The primary care sector only costs 4% of the curative part of the national healthcare budget (Health care bill 2015), but the referrals from GPs to hospital (and other) care create a much larger burden on the healthcare budget (Health care bill 2015). As the population ages and therapeutic options increase, patients live longer and have more chronic illnesses, which in turn increases the referral rates. Hence to reduce costs in the hospital sector it is important to prevent unnecessary referrals to the hospital. Continuity of Care (CoC) could be helpful towards preventing these unnecessary referrals.

Continuity of care (CoC) has proven to be related to healthcare costs (De Maeseneer et al. 2003). CoC is the relationship between a GP and a patient that lasts longer than a single period of illness (Saultz 2003). CoC has different dimensions: informational (the availability of patients records), longitudinal (a long-term relationship between patient and physician) and interpersonal continuity (relationship with the same GP) (Saultz 2003). In addition to lower healthcare costs, a high CoC is also associated with a longer life (Maarsingh et al. 2016) and higher satisfaction of patients with their physician (Adler, Vasiliadis & Bickell 2010, Saultz, Albedaiwi 2004, Mainous et al. 2001, Nutting et al. 2003). Next, we will focus on the hospital care sector.

HOSPITAL SECTOR

The hospital sector in the Netherlands is run under a FFS financing system, also called the Diagnosis Treatment Code (DBC) system. For every combination of a diagnosis and its subsequent treatment the hospital receives a preset fee, regardless of the consumption of health care during the term of the DBC. This system encourages hospitals to provide more items of care than is necessary (Liddy et al. 2014). The introduction of this system has proven to elevate the costs in the hospital sector (Health care costs 2017), and these costs continue to rise.

To take a closer look at the relation between patient characteristics and healthcare consumption in the hospital, it is necessary to choose a specific DBC to analyze. In this thesis a choice was made for the DBC Total Hip Arthroplasty (THA). THA is a surgical procedure in which the hip joint is replaced by an artificial joint. It has proven to be a cost-effective therapy for osteoarthritis of the hip (Chang, Pellisier & Hazen 1996, Mota 2013) and is also a common therapy for other hip anomalies (e.g. osteonecrosis, congenital hip dysplasia and trauma). An overview of the causes, prevalence and therapy of osteoarthritis of the hip is presented in Table 2. Even though the choice for analysis fell on a specific DBC in this thesis, every other DBC with planned admission and surgical intervention could have been used.

In the DBC system hospitals receive the same reimbursement for all THA patients regardless of age, comorbidities or other patient factors (Ellis 1998, Geissler et al. 2012). Within the academic literature there is a call for a better financing system that provides reasonable remuneration for every single patient instead of one-price-for-all – for example authors from the USA who question why the remuneration for a primary THA is the same as a conversion THA after a hip fracture, even though the latter will cost approximately 25% more (Chin et al.

2016); or why remuneration for a THA due to osteoarthritis equals the remuneration for a THA due to congenital hip dysplasia (Ashraf et al. 2014). Another example is the fact that hospitals lose money on revision THAs (Crowe, Sculco & Kahn 2003). Nowadays there is a wide spread in prices of THA amongst hospitals (Ejaz et al. 2016). Costs can differ enormously between patients, especially when they experience adverse events (Culler et al. 2016).

Table 2. Overview of the main causes, prevalence, and therapy of osteoarthritis of the hip

Causes	High age (Cram et al. 2011) High Body Mass Index (BMI) (Flugsrud et al. 2006, Holliday et al. 2011, Maradit Kremers et al. 2014) Intense sporting activities (Lievense et al. 2003) Intense physical workload (Bierma-Zeinstra, Koes 2007)
Prevalence in the Netherlands (2015)	1.6% (males) 2.9% (females) (*Prevalence of osteoarthritis* 2015)
Therapy	Pain medication (Berger et al. 2011) Physical therapy (Pisters et al. 2007) Infiltration of the hip joint with anti-inflammatory medication (van Middelkoop et al. 2016) Total hip arthroplasty (Chang, Pellisier & Hazen 1996, Mota 2013)

Hospitals could profit from a differentiated financing system for THA, especially as complexity of THA patients in on the rise. Nowadays more patients are found to be eligible for a THA than ever before. Patients with a higher age, a higher body mass index (BMI) and more comorbid illnesses are operated more often than before (Maradit Kremers et al. 2014, Singh, Lewallen 2014). This trend increases the number of THAs (Cram et al. 2011, Higuera et al. 2011, Liu et al. 2009), especially the number of complex patients who receive a THA.

To gain insight into the costs of patients that receive a THA it is important to increase the knowledge on the amount and type of care that patients require around this surgical procedure. Ideally, the financial compensation for THA would depend on patient characteristics that are known prior to the hospital admission. Besides a better financial starting point, knowledge about the care consumption of THA patients (such as length of hospital stay) would also enable hospitals to better plan and organize their necessary postoperative care. And it would be more just to receive a reimbursement for a DBC that reflects the healthcare consumption of the patient, as opposed to a fictive sum of money.

OUTLINE OF THIS THESIS

This thesis presents the results of several studies about the relation between healthcare consumption and patient characteristics. Part I addresses the first research question: *Which patient characteristics are related to healthcare consumption in the primary care sector in the Netherlands?*

Chapter 2 explores the relation between patient characteristics and healthcare consumption in the primary care sector. Healthcare consumption is defined here as the number of consultations and visits patients have with their GP per year. The relation between a specific patient characteristic, Continuity of Care, and healthcare consumption is presented in **Chapter 3**. The rate of referral is used a definition of healthcare consumption here. Determining the relation between CoC and the referral rate could provide more insight into factors that could temper healthcare use in the hospital sector.

The second part of the thesis focuses on the second research question: *Which patient characteristics are related to healthcare consumption in the hospital sector in the Netherlands?*

It starts off with a systematic review about the relation between patient characteristics and healthcare consumption after total hip arthroplasty (THA) in **Chapter 4**. Here length of hospital stay (LOS) and hospital costs are used as operationalization of the consumption of health care. Length of hospital stay (LOS) is a measure of consumption of care after THA that has been widely studied. Previous literature has demonstrated that several patient characteristics are related to LOS after THA. For example, patients with a high body mass index (BMI) (Maradit Kremers et al. 2014), patients with low social economic status (SES) (Inneh et al. 2015) and older patients (den Hartog et al. 2015; Jauregui et al. 2015) are subject to a longer LOS on average. Various authors have analyzed the effects of scores on several comorbidity indexes on the LOS after THA, e.g. for the American Society of Anesthetists (ASA) score (Abbas et al. 2011, Cullen et al. 1994) and the Charlson Comorbidity Index (CCI) (Higuera et al. 2011, Armitage, van der Meulen 2010).

It is also known that patients with more comorbidities have higher chances of complications around the THA, have higher hospital costs, are more prone to readmission within 30 days after surgery, and have a higher risk of mortality due to THA (Paxton et al. 2015, Nichols, Vose 2016, Schairer et al. 2014, Rozell et al. 2016). These outcomes are also related to healthcare consumption around THA. In previous literature authors have also studied the effects of medication use on LOS for various hospital admissions (Farley, Harley & Devine 2006, Parker, McCombs & Graddy 2003). Higher preoperative medication use was related to a longer LOS after different types of surgical procedures, but the effects of preoperative

medication use solely on LOS of THA patients specifically has never been studied. The effects of medication use prior to THA on LOS is analyzed in **Chapter 5**.

Lastly, the association between patient characteristics and the healthcare consumption of the orthopedic ward after THA is analyzed in **Chapter 6**. In this study healthcare consumption is defined as the time that nursing personnel spend on patients and their perceived workload during the first postoperative day. It is hypothesized that patient characteristics related to longer LOS after THA are also predictors for the time and burden in the work of nursing personnel at the orthopedic ward, such as for the patient characteristic of comorbidity (or comorbidity index). So far only one study has demonstrated a relation between patient comorbidity and the number of activities of nursing personnel during hospital admission after THA (Lee, Moorhead 2014).

The thesis ends with a General Discussion in **Chapter 7**, putting the results of the previous chapters into a broader perspective and ending with conclusions and suggestions for future research.

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CHAPTER 2

TOWARDS A DIFFERENTIATED CAPITATION SYSTEM: RELATION BETWEEN PATIENT CHARACTERISTICS, CONTACTS AND REMUNERATION

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ABSTRACT

Background

A new remuneration system could curb primary healthcare costs. A differentiated capitation system based on patient characteristics could be the best mix for remuneration. To test the feasibility of such a system, we examined the number of contacts between patients and GPs, the related remuneration, and the relationship with age, sex and comorbidity.

Methods

Retrospective observational study including 29,304 primary care patients in the Netherlands. Age, sex and comorbidity were related to number of contacts per patients per year and consecutive remuneration using a negative binomial regression analysis.

Results

Males, younger patients and patients with no comorbidities visit their GP least often. Medically unexplained physical symptoms (MUPS), diabetes and severe back complaints generate the most contacts; diabetes is specifically related to higher remuneration.

Conclusion

Several patient characteristics are related to the number of contacts patients have with their GP and the consecutive remuneration. This study can be used as an input to create a differentiated capitation system.

INTRODUCTION

Expenditures in healthcare continue to rise. Changing the remuneration system of general practitioners (GPs) could curb this trend (Flodgren et al. 2011, Gosden et al. 2000). Three types of remuneration are used in general practice: salary, capitation and fee-for-service (FFS) (Flodgren et al. 2011, Gosden et al. 2000). Under salary systems, GPs receive salary for working a preset number of hours. Capitation consists of a periodic remuneration per patient. FFS pays the GP for every item of service that is provided. Many countries have a mixed system of remuneration and/or use different remuneration systems.

In several countries the majority of GPs is paid using a mixed capitation and FFS system. This provides the benefits of capitation, such as a base income, rewarding prevention and less referrals due to FFS (Krasnik et al. 1990, Iversen, Luras 2000). It prevents cream-skimming under capitation-only systems (Woodward, Warren-Boulton 1984) and delivering unnecessary care under FFS only (Hennig-Schmidt, Selten & Wiesen 2011, Chaix-Couturier et al. 2000).

To curb expenditures, the Dutch government aims to eliminate FFS. They assume that a differentiated capitation system would be most suitable to provide both a reasonable remuneration and prevent the provision of unnecessary care (Duth Health Care Authority. June 2012). It provides GPs with a capitation rate that is adjusted for the burden that the patient puts on them, and reduces the administrative burden.

Ideally, a differentiated capitation system incorporates patient characteristics that predict the number of consultations per patient. Demographics combined with a measure of comorbidity partly explains the differences in consultation rates in general practice (Brilleman, Salisbury 2013; Schellevis et al. 1994). Female sex, higher age and ≥ 1 comorbidity are associated with higher costs in general practice (Brilleman et al. 2013; Rice

et al. 2000). Most of these studies were performed in the UK and Germany, the results may not be internationally generalizable. All studies except one use a measure of comorbidity (e.g. the Charlson comorbidity index) and do not study the effects of all individual comorbidities. We want to test the feasibility of a differentiated capitation system in the Netherlands using demographic patient data and individual comorbidities.

This study aims to determine the number of contacts patients have with their GP during one year in the Netherlands. It evaluates whether the number of contacts is associated with patient demographics and comorbidity. Second aim is to determine the remuneration per patient per year and to evaluate its relation with the same patient characteristics.

METHODS

This is a retrospective cohort study. Data were extracted from the Registration Network Groningen (RNG); this is a register of all patient contacts from 17 GPs in the Netherlands. These practices code all contacts with ICPC codes. About 30,000 patients are registered and are representative for the national population (Biermans et al. 2008).

All patient data of 2011 was included. Demographic factors (age and sex), contacts and episodes were extracted. Episodes were defined as current or previous periods of illnesses. Patients were screened for comorbidities. A validated ICPC code list was used to cluster codes into comorbidities (Maas et al. 2009) (Appendix 1). This analysis includes only chronic comorbidities. Excluded from the analysis were short-term illnesses (e.g. urinary tract infections).

Contacts

The primary outcome measure is the 'number of contacts per patient per year' (from here on 'number of contacts'). All recordable and declared contacts with the GP were included: consultations, home visits, telephone calls, requests for medication, and a large number of diagnostic tests and interventions (e.g. ECG, spirometry, urinalysis). Excluded were contacts which seldom occurred (i.e. < 50 times in total, e.g. MRSA screening, euthanasia), or which most GPs did not offer (sterilisation and tympanometry).

Remuneration

Remuneration per patient per year (from here on 'remuneration') was calculated using the tariff list of the Dutch Health Care Authority (2011). Tariffs that are negotiable with healthcare insurers were collected from the general practices. Remuneration was calculated by summing the contacts, multiplied by the corresponding tariff. Capitation fees were added, adjusted for the period of time that the patient was registered.

Statistical analysis

We used descriptive statistics to calculate the patient characteristics age, sex, and number and type of comorbidity. Differences between males and females were determined with a Student T-test. The outcome measures (number of contacts and remuneration) were not normally distributed and there was evidence of overdispersion of the data. Therefore we performed a negative binomial regression analysis to determine the relation between patient characteristics, number of contacts, and remuneration. Age and number of comorbidities were included as interval variables, and sex and the presence of different

comorbidities as nominal data. The presence of a specific comorbid disease was compared with the absence of that disease. Incident rate ratios (IRR) and confidence intervals were calculated. The IRR represents the change in the independent variable when the dependent variable changes one unit (for interval or continuous data) or one category (for nominal data).

All statistical analyses were performed using SPSS 20.0 with a significance level of $p<0.05$.

The study was conducted in accordance with the regulations of the Medical Ethical Board of University Medical Center Groningen, the Netherlands.

RESULTS

A total of 29,304 patients were included. Table 1 presents the patient characteristics and comorbidities. Medically unexplained physical symptoms (MUPS), hypertension and chronic eczema are the most common comorbidities. Due to the small numbers, patients with ≥ 7 comorbidities are grouped.

Table 2 shows the contacts that occur most frequently (≥ 85% of all the contacts), tariffs and remuneration. There is no tariff for ordering prescriptions.

Demographic differences

In 2011, men contacted their GP (on average) 5.0 times and women 7.5 times. Mean total remuneration for males was €122.08 and for female patients €126.54 (both $p<0.00$).

Table 1. Demographic and medical characteristics of the study group (n=29,304) that were enrolled in 2011

Age (years ± SD)	38.0 ± 22
Female (%)	50.7
Comorbidities (%)	
Hypertension	12.1
Heart disease	4.3
Coronary heart disease	3.4
Cerebral Vascular Accident	3.5
Osteoarthritis	1.4
Arthritis	1.4
Depression	3.5
Anxiety disorder	3.3
Asthma / COPD	6.0
Vertigo	1.7
Migraine	3.3
Gastrointestinal complaints	1.6
Medically Unexplained Physical Complaints	24.9
Chronic eczema	7.6
Diabetes	4.9
Cancer	2.1
Neck and back complaints	1.8
Severe back complaints	0.1
Neck and shoulder complaints	3.5
Elbow, wrist and hand complaints	3.5
Comorbidity clusters (%)	
0	55.4
1	20.1
2	12.0
3	6.7
4	3.3
5	1.5
6	0.6
≥ 7	0.5

Table 2. Most common contacts and their associated remuneration per patient during 2011 (n=29,304)

Contact type	Mean number ± SD	Tariff (€)	Mean remuneration ± SD (€)
Consult	2.08 ± 2.7	9.11	18.93 ± 24.2
Prescription	1.57 ± 4.0	-	-
Telephone consultation	1.21 ± 2.5	4.56	5.50 ± 11.4
Consult > 20 minutes	0.33 ± 0.9	18.22	5.97 ± 15.6
Home visit	0.16 ± 1.1	13.67	2.14 ± 14.8
Total number of contacts	6.25 ± 8.6	-	-
Total remuneration	-	-	132.84 **±** 119.9

Contacts

Table 3 presents the relation between the number of contacts and patient characteristics. Males, younger patients and patients with no comorbidities have the fewest contacts.

Males have 0.79 contacts compared to 1 contact by females. Several comorbidities are related to more contacts (MUPS, Diabetes, Asthma/COPD, severe back complaints and depression).

Remuneration

Table 4 presents the relation between remuneration and patient characteristics. Again males, younger patients and patients with no comorbidities are related to lower remuneration. Of the comorbidities, only diabetes is related to higher remuneration.

Table 3. Determinants for the number of contacts per patient per year in 2011 (n=29,304)

Determinant	IRR	95% CI			p-value
Male sex	0.79	0.77	to	0.79	<0.001†
Age	1.01	1.01	to	1.01	<0.001†
Number of comorbidities	1.42	1.37	to	1.46	<0.001†
Presence of comorbidity:					
High blood pressure	0.97	0.94	to	1.01	0.121
Cardiac disease	0.90	0.87	to	0.93	<0.001†
Coronary heart disease	0.79	0.76	to	0.81	<0.001†
CVA	0.92	0.89	to	0.95	<0.001†
Neck and back complaints	0.96	0.93	to	1.00	0.049†
Severe back complaints	1.16	1.04	to	1.29	0.010†
Severe neck and shoulder complaints	0.74	0.72	to	0.77	<0.001†
Severe elbow, wrist and hand complaints	0.89	0.85	to	0.92	<0.001†
Osteoarthritis	0.85	0.82	to	0.88	<0.001†
Arthritis	1.02	0.99	to	1.06	0.198
Depression	1.09	1.06	to	1.13	<0.001†
Anxiety disorder	1.01	0.97	to	1.04	0.872
Asthma / COPD	1.10	1.06	to	1.14	<0.001†
Migraine / severe headache	0.87	0.84	to	0.90	<0.001†
Vertigo	0.69	0.67	to	0.72	<0.001†
Severe intestinal complaints	0.85	0.82	to	0.88	<0.001†
MUPS	1.27	1.19	to	1.31	<0.001†
Chronic eczema	0.98	0.95	to	1.01	0.165
Diabetes	1.23	1.19	to	1.27	<0.001†
Cancer	1.02	0.98	to	1.05	0.324

COPD, chronic obstructive pulmonary disease; CVA, cerebral vascular accident; MUPS, medically unexplained physical symptoms; IRR, incidence rate ratio; CI, confidence interval.
†p<0.05

Table 4. Determinants for the costs per patient per year in 2011 (n=29,304)

Determinant	IRR	95% CI			p-value
Male sex	0.91	0.89	to	0.93	<0.001†
Age	1.00	1.00	to	1.00	<0.001†
Number of comorbidities	1.36	1.12	to	1.65	0.002†
Presence of comorbidity:					
High blood pressure	0.91	0.75	to	1.11	0.355
Cardiac disease	0.84	0.68	to	1.02	0.081
Coronary heart disease	0.78	0.63	to	0.95	0.015†
CVA	0.87	0.71	to	1.08	0.212
Neck and back complaints	0.85	0.69	to	1.06	0.145
Severe back complaints	0.92	0.60	to	1.41	0.711
Severe neck and shoulder complaints	0.76	0.62	to	0.93	0.007†
Severe elbow. wrist and hand complaints	0.85	0.70	to	1.04	0.124
Osteoarthritis	0.81	0.65	to	1.00	0.054
Arthritis	0.96	0.78	to	1.19	0.737
Depression	0.93	0.76	to	1.14	0.468
Anxiety disorder	0.91	0.75	to	1.12	0.390
Asthma / COPD	0.97	0.79	to	1.18	0.763
Migraine / severe headache	0.80	0.65	to	0.98	0.029†
Vertigo	0.77	0.79	to	1.18	0.013†
Severe intestinal complaints	0.82	0.66	to	1.01	0.061
MUPS	0.96	0.78	to	1.17	0.658
Chronic eczema	0.88	0.72	to	1.07	0.197
Diabetes	2.49	2.04	to	3.04	<0.001†
Cancer	1.03	0.84	to	1.26	0.812

COPD, chronic obstructive pulmonary disease; CVA, cerebral vascular accident; MUPS, medically unexplained physical symptoms; IRR, incidence rate ratio; CI, confidence interval.
†p<0.05

DISCUSSION

The aim of this study was to provide insight into which type of patients put the highest burden on the GP and, for whom the remuneration should be the highest.

We found that asthma/COPD, diabetes, depression, MUPS and serious back complaints are related to more contacts. Cardiovascular diseases and musculoskeletal disorders (amongst others) are related to fewer contacts.

There are several possible explanations for these findings. Uncomplicated asthma/COPD, diabetes and depression are managed by the GP in the Netherlands and require follow-up. MUPS and severe back complaints can lead to many concerns and frequent visits to the GP. MUPS often involves dealing with the symptoms rather than finding a cause, and GPs are best suited to help patients manage these complaints.

Patients with cardiovascular diseases, severe intestinal complaints (Crohn's disease, colitis ulcerosa) and severe osteoarthritis (leading to arthroplasty) often visit the hospital for these illnesses. Musculoskeletal disorders usually have short-term self-limiting episodes of symptoms that do not require frequent contact with the GP. Because vertigo and migraine have few therapeutic options, most patients only need to be assured of the benign character of these disorders. Thus, having comorbidity does not necessarily lead to frequent contacts with the GP.

Strengths and limitations

This study is a large, retrospective study using registered data from primary care. Data from one calendar year (2011) avoids seasonal influences. The RNG register is a validated patient register that is representative for the national population. The inclusion of individual

comorbidities adds up to the evidence from existing literature.

This study uses an ICPC comorbidity list to cluster codes into comorbidity groups. Several groups have overlapping ICPC codes. Double counting might have consequences for the outcomes of this study. MUPS is a category that is difficult to define, and using this category as a comorbidity presents major difficulties for a differentiated capitation system. Since only a few ICPC code lists cluster comorbidity into groups and the list we selected has been validated(Maas et al. 2009), we decided to use this list in its original version.

Comparison with literature

Women have (on average) higher costs in primary care than men (Engstrom et al. 2006); the same applies to older patients (Charlson et al. 2008). Multimorbidity is associated with more contacts (Brilleman, Salisbury 2013, Gravelle et al. 2003, Laux et al. 2008). Brilleman et al. studied different types of comorbidity measures. A model containing demographic factors, GP practice and number of prescribed drugs explained 42% of the variation in consultation rate; individual comorbidities were not included (Brilleman et al. 2013). Gravelle et al. used self-reported morbidity (Gravelle et al. 2003), which is known to be less valid than registered morbidity in patients' files (Datta Gupta, Jurges 2012). Schellevis et al. present the only Dutch study and found that comorbidity was related to more consultations (Schellevis et al. 1994). This 20-year old study did not correct for demographic influences.

The association between multimorbidity and higher costs was also determined by Brilleman et al.(Brilleman et al. 2013); their study mainly analyzed the effects of the co-occurrence of chronic conditions. Dixon et al. provided a formula that could explain up to 77% of the

variation in remuneration at practice level, but only 12% at patient level, which is therefore less applicable in practice (Dixon et al. 2011).

Implications for research and/or practice

This study is a starting point to determine the feasibility of a differentiated capitation system. A disadvantage of such a system is the potential incentive it creates to boost the remuneration of the GP. Especially the inclusion of MUPS presents a shortcoming. A full capitation system can also lead to more referrals, which can be (partly) overcome by rewarding the adherence to guidelines.

The present analysis does not incorporate the actual investment in time that GPs make. The number of contacts is only a subjective measure of time. The real-time investment of GPs, related to patient characteristics, provides support for a truly differentiated capitation system.

Conclusion

Several patient characteristics are related to the number of contacts that patients have with their GP and to the remuneration. Comorbidities with high-intensity contact are MUPS, diabetes and severe back complaints. The relationship with remuneration is less strong.

Ethical approval / Conflict of Interest

The study was conducted in accordance with the regulations of the Medical Ethical Board of

University Medical Center Groningen, the Netherlands. No funding sources were used to support this study. All authors have declared no competing interests.

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Appendix I. ICPC-code list for comorbidity

Cardiovascular	
High blood pressure	K85 K86 K87
Cardiac disease	K71 K73 K74 K77 K78 K79 K80 K81 K82 K83 K84
Coronary heart disease	K74 K75 K76
CVA	K89 K90
Musculoskeletal	
Neck and back complaints	L01 L02 L03 L84 L86
Severe back complaints	L02 L03 L85 L86
Severe neck and shoulder complaints	L01 L08 L83 L92
Severe elbow, wrist and hand complaints	L10 L11 L12 L72 L74
Osteoarthritis	L89 L90 L91
Arthritis	L88 T92
Mental	
Depression	P03 P76
Anxiety disorder	P01 P74
Respiratory	
Upper respiratory tract infection	A77 R72 R74 R75 R76 R80
Bronchi(oli)tis/pneumonia	R78 R81
Asthma / COPD	R91 R95 R96
Neurological	
Migraine / severe headache	N01 N02 N03 N89 N90 N92
Vertigo	N17
Digestive	
Severe intestinal complaints	D81 D85 D86 D92 D93 D94
Infectious disease of the intestinal canal	D70 D73

Miscellaneous	
Medically Unexplained Physical Symptoms (MUPS)	A01 A04 D01 D08 D09 D12 D18 D21 D93 K01 K02 K04 L01 L02 L03 L08 L09 L14 L20 N01 N02 N17 P06 P20 R02 R21 T03 T07 T08
Chronic eczema	S86 S87 S88
Acute urinary tract infection	U70 U71 U72
Diabetes	T88 T90
Cancer	A79 B72 B73 B74 D74 D75 D76 D77 F74 H75 K72 L71 N74 R84 R85 S77 S80 T71 T73 U75 U76 U77 U79 W72 X75 X76 X77 X81 Y77 Y78

COPD, chronic obstructive pulmonary disease; CVA, cerebral vascular accident; MUPS, medically unexplained physical symptom

CHAPTER 3

CONTINUITY OF CARE AND REFERRAL RATE: CHALLENGES FOR THE FUTURE OF HEALTH CARE

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Submitted

ABSTRACT

Background

Continuity of Care (CoC) potentially reduces the health care consumption of patients. CoC can reduce the number of referrals to specialist care. It is unknown whether there is a difference for the referral to specific medical specialties. We want to determine the relationship between CoC and referral rate (the number of referrals per patient per year), and second for which medical specialties this relationship is strongest.

Method

A retrospective cohort study of 19,333 patients in the primary care setting in Northern Netherlands (2013-2014). Number of contacts with patients' own GP and other GPs were calculated, and referral rates were determined. CoC was defined as a dichotomous variable (absent or present) or as percentage of number of contacts.

Results

The odds for being referred is higher for older patients, females, and patients with a high number of contacts. The OR for CoC was the highest predictive factor for the referral rate (OR: 0.817). The referral rate is specifically higher for patients with a low CoC that are referred to Pediatrics.

Conclusion

Patients that only contacted their own GP were almost 20% less likely to be referred to specialist care. When CoC is low, the odds of being referred to Pediatrics is higher. Even though developments put pressure on CoC (GPs who work part-time, pressure for longer opening hours) policymakers should invest in this cornerstone of primary care to temper healthcare expenditures.

INTRODUCTION

As healthcare costs are on the rise, an increasing part of the Gross Domestic Product (GDP) is spent on health care (Lorenzoni, Belloni & Sassi 2014). Policymakers try to restrain budgets from being exceeded by availing themselves with a variety of measures. One of the measures that can tame healthcare spending and count on the approval of both policymakers and field experts is a strong primary care system (Kocher, Chigurupati 2016, Kringos et al. 2013). In a strong primary care system, the General Practitioner (GP) is the gatekeeper who refers patients to specialist care in the hospital (Allen et al. 2011). The Netherlands adopted such a primary care system long ago. In this system, patients are registered to a single GP (henceforth: 'own GP').

If GPs are able to prevent unnecessary referrals to specialist care, this could have a reducing effect on healthcare costs. A factor that potentially reduces the number of referrals per patient is Continuity of Care (CoC) (O'Donnell 2000). CoC is the relationship between a GP and a patient that extends beyond a single episode of illness (Saultz 2003). CoC is regarded to be one of the cornerstones of primary health care (Allen et al. 2011). There are several dimensions of CoC: informational (availability of patients records), longitudinal (long-term relation) and interpersonal (relation with the same GP) continuity (Saultz 2003). Previous literature has hypothesized that when patient and GP are familiar with each other (interpersonal and longitudinal continuity), the patient can be reassured by the GP more effectively and fewer unnecessary referrals are required to answer the patient's questions (Saultz, Albedaiwi 2004).

Previous literature has demonstrated that CoC has a moderating effect on the number of hospital admissions (Bayliss et al. 2015, Cheng, Chen & Hou 2010, Chauhan et al. 2012,

Barker, Steventon & Deeny 2017). Patients have more confidence in their GP and are more satisfied with their GP when they experience CoC (Saultz, Albedaiwi 2004, Adler, Vasiliadis & Bickell 2010, Mainous et al. 2001, Nutting et al. 2003). CoC also leads to lower healthcare costs (De Maeseneer et al. 2003, Hollander, Kadlec 2015). In Norway, CoC led to a lower number of referrals to hospital care (Hansen et al. 2013). In the United States absence of CoC was associated with more specialist care per patient and higher healthcare costs (Starfield et al. 2009, Raddish, Horn & Sharkey 1999). For the Dutch primary health care system and its specific characteristics, it is unknown what the strength between CoC and referral rate is.

It is unknown for the referrals to which medical specialties CoC is most important. For some specialties and illnesses it could be more evident that a patient needs referral to specialist care than for others. For example, for surgical specialties, in which illness and the need for referral can be better defined, referral could be less dependent of the GP. For other specialties, illnesses and the need for specialist care could be less clear and referral could be more dependent of the GP and the CoC (for example in the case of medically unexplained physical symptoms (MUPS)).

This study was conducted to analyze two research questions – to determine the relationship between CoC and referral rate (the number of referrals per patient per year) in a Dutch primary care setting and for which medical specialties this relationship is the strongest.

METHODS

Design

This is a retrospective cohort study with data from the Registration Network Groningen (RNG). The RNG is a register of all patient contacts from three large primary care centers in the northern part of the Netherlands, where on average 17 GPs work. All these patient contacts are coded with the International Classification of Primary Care (ICPC) codes. About 30,000 patients are registered with the RNG. The register is representative of the national population (Biermans et al. 2008).

Patients

Patients were included in the cohort when they had two or more face-to-face contacts with a GP from the practice the patient is registered in during the two-year study period (2013-2014). Patients with one or no contacts were excluded, as they had too few contacts to ensure a good relationship with their GP. Both consultations at the practice and home-visits were included. Telephone calls and e-mail consultations were excluded as they were less traceable to the GP.

Demographic data was collected (age and sex) for every patient. We also collected the number of face-to-face contacts of the patient with a GP, both consultations at the GP's office, and home visits. We determined the number of contacts that patients had with the GP they are registered with ("own GP") and the number of contacts with other GPs. The number of referrals per patient during the study period was determined, as was the medical specialty they were referred to. When there were fewer than 50 referrals to a medical

specialty during the two-year study period, that specialty was not separately analyzed in the second part of the analysis (the relation between CoC and medical specialty).

Continuity of Care (CoC) was defined as a dichotomous variable. It is present when patients only had face-to-face contacts with their own GP during the previous two years. When patients had one or more contacts with another GP, CoC is absent. This definition is in line with the definition of CoC in earlier literature (Barker, Steventon & Deeny 2017, Hansen et al. 2013).

In order to evaluate the relative contribution of CoC of individual medical specialties we compared CoC percentages per specialism. A CoC percentage was calculated as the share of contacts with the patients' own GP opposed to the total number of contacts. The relative contribution was calculated by comparing the CoC percentage for patients who were referred to a specific medical specialty with the CoC percentage of all others who were not.

Main and secondary outcome measures

The main outcome measure is the referral rate, defined as the number of referrals per patient per year. These referrals comprise both referrals to specialist care for outpatient consultation and treatment, as well as referrals for hospitalization due to acute illnesses. Referrals to other institutions (for example physical therapy and psychology) were not included in the referral rate. The secondary outcome is the medical specialty where the patient is referred to.

Statistical analysis

We used descriptive statistics to calculate the patients' age, sex, and number and type of referrals. The main outcome measure (number of referrals) was not normally distributed, therefore we used a Poisson regression analysis to determine the relation between number of referrals and CoC. CoC was included as a dichotomous variable (1=CoC, 0=no CoC). The relation between number of referrals and CoC was adjusted for the influence of the age and sex of patients, as well as for the number of contacts patients had with GPs during the study period (when patients have many contacts with GPs, odds are higher of them being referred to specialist care). Odds Ratios and 95% confidence intervals were calculated.

To determine the relation between medical specialty and CoC, we tested whether the CoC percentage of referred patients was different compared to non-referred patients. Since this outcome variable was normally distributed, a student T-test was used to analyze the data for statistical significant differences. All statistical analyses were performed using SPSS 20.0 with a significance level of $p<0.05$.

RESULTS

Demographic patient data is presented in Table 1. After excluding patients that had <2 contacts with a GP during the study period, 19,333 patients remained in the dataset. These patients visited their GP on average 5.67 times (range 2-84) in two years. For every 100 patients per year, on average 41.5 referrals to specialist care were made. Approximately one quarter of the patients only had contact with their own GP (=CoC is present).

The relation between CoC, patient characteristics and number of referrals (all referrals together) is presented in Table 2. The odds of being referred is higher for older patients, for females and for patients with a higher number of contacts with the GP. CoC was the strongest factor associated to number of referrals (OR: 0.817), corrected for the other characteristics (age, sex and number of contacts). When CoC is present, the odds of being referred are lower than when CoC is absent.

Table 1. Demographic patient data (n=19,333)

Age	42.0 (±22.9)
Sex (female)	10,836 (56.0%)
Contacts* (during 2 years)	5.67 (4.8)
Number of referrals (during 2 years) per patient	0.83 (1.1)
Continuity of Care	
- Present	4910 (25.4%)
- Absent	14423 (74.6%)

Data are presented as mean (SD) or number (%).
**Patients with <2 contacts during 2 years were excluded*

Table 2. Relation between Continuity of Care, demographic factors and number of referrals

	OR	95% Confidence Interval	p-value
Sex (male)	0.960	0.930-0.991	0.011
Age	1.006	1.005-1.007	<0.001
Number of contacts	1.050	1.048-1.052	<0.001
Continuity of Care (present)	0.817	0.785-0.851	<0.001

OR: Odds Ratio

Table 3 presents the difference in percentage of CoC per medical specialty. For five medical specialties - gastroenterology, ophthalmology, psychiatry, dermatology and neurology - the number of referrals is *higher* for patients with a *high* CoC percentage compared to low CoC percentage. For one medical specialty, pediatrics, the number of referrals is *higher* for patients with a *low* CoC percentage.

DISCUSSION

Summary

This study found a statistically significant relation between referral rate and Continuity of Care. Patients that were only seen by their own GP during the two-year study period were almost 20% less likely to be referred to specialist care than patients who were also seen by other GPs (OR 0.817). In comparison to other medical specialism the percentage CoC is very low for children referred to a paediatrician (53%).

Strengths and limitations

This study included almost 20,000 patients from a representative sample of the Dutch population (Biermans et al. 2008). All patients were included, in contrast to a previous study in which only patients aged >30 were included (Hansen et al. 2013). In addition, we only used electronic patient files as source of data instead of the patients' recollection (Hansen et al. 2013) of the consultations, as we feel that these data are more reliable. The RNG is considered to be a reliable and accurate data source and over the years it has proven to be so. These factors will have improved the reliability and generalizability of our study.

Table 3. Mean continuity of care (CoC) per medical specialty (n=19,333)

	CoC when referred	CoC when not referred	p-value
Anesthesiology	0.68	0.60	0.062
Cardiology	0.62	0.60	0.196
Surgery	0.61	0.61	0.939
Dermatology	0.63	0.60	0.002*
Gynecology	0.63	0.60	0.091
Internal Medicine	0.61	0.60	0.571
Dental Surgery	0.59	0.60	0.741
ENT Medicine	0.60	0.61	0.495
Neurology	0.64	0.63	0.003*
Pulmonology	0.61	0.61	0.782
Gastroenterology	0.66	0.60	<0.001*
Ophthalmology	0.65	0.60	<0.001*
Orthopedics	0.62	0.60	0.276
Plastic Surgery	0.61	0.61	0.702
Pediatrics	0.53	0.61	<0.001**
Psychiatry	0.64	0.60	0.001*
Rheumatology	0.61	0.61	0.783
Rehabilitation Medicine	0.62	0.60	0.430
Sports Medicine	0.55	0.61	0.127
Urology	0.62	0.60	0.242
Vascular Surgery	0.62	0.61	0.741

Mean Continuity of Care (CoC) when patients were either referred or not referred to specialist care. p-value <0.05; CoC when referred higher than CoC when not referred*
*** p-value <0.05; CoC when referred lower than CoC when not referred*

Limitations of this study are that we did not correct for other factors that can influence referral rate such as income, education, comorbidity and self-rated health. We did not examine the effects of partial CoC either – that is CoC provided by the same two GPs who fill in for each other. This system may also be having a tempering effect on the referral rate. Lastly, we did not include the various other contacts of patients with other personnel of the general practice, even though the contacts with the medical assistant or primary care nurse can also be an important part of CoC.

Comparisons with existing literature

Previous literature also found a statistically significant lower referral rate in patients when CoC was present (Hansen et al. 2013, Starfield et al. 2009, Raddish, Horn & Sharkey 1999). These studies defined CoC by its longitudinal dimension (long-term relationship) or its interpersonal dimension (always the same GP). This study is the first to use the combination of both a longitudinal (two years) and a personal relation (only 1 GP) to explain the effect of CoC on referral rates. The outcomes support the hypothesis that providing CoC can reduce the number of referrals to specialist care, which ultimately could reduce healthcare costs.

The Dutch primary care system promotes both a longitudinal and an interpersonal relation between patient and GP. However, nowadays there are several threats to Continuity of Care. In recent decades increasing numbers of medical students are female (House 2009, Jefferson, Bloor & Maynard 2015), and the same trend is seen in primary health care (House 2009). Female GPs are less likely to work full-time and are less willing to be self-employed (Peckham 2015). These developments threaten CoC, as patients are less likely to be able to visit their own GP exclusively.

Another threat is the 24/7 economy. Patients are used to everything being available round-the-clock – stores have long opening hours every day of the week, purchases can be made online whenever the customer wants. This trend can make it more likely that patients will consult a GP outside standard weekday opening hours. There is already a tremendous increase in consultations at out-of-hour GP services that cannot solely be explained by an aging society (Smits et al. 2014). This trend is also a threat to CoC.

It is to be expected that these trends will continue to put pressure on continuity of care. In light of these developments GPs, patients and policymakers have to work together to create solutions to improve CoC. The establishment of duo practices could be promoted, where two GPs ensure continuity for their patients. GPs could also be encouraged to offer longer or more differentiated opening hours, as opposed to the traditional 8 AM to 5 PM hours.

This study also analyzed the relation between CoC and medical specialty. An interesting finding is that patients are referred more often to pediatrics when CoC is low. This could be due to the lack of trust and confidence children's parents have in an unfamiliar GP (due to low CoC), or the inability of a GP to reassure the parents of an unknown patient. This finding could be used for educational purposes, and provides a focus on which residents can be trained to reduce unnecessary referrals.

We also found that patients are more often referred to gastroenterology, ophthalmology, psychiatry, dermatology and neurology when the CoC percentage is higher opposed to patients that are not referred. Possibly this is due to the fact that many referrals for these specialties are not emergencies and patients are willing to wait to consult their own GP in order to be referred. This is the case, for example, when it comes to chronic abdominal pain

and rectal bleeding for gastroenterology, cataract for ophthalmology and radicular pain for neurology. But other explanations could also be valid.

Implications for practice

Continuity of Care (CoC) is associated with fewer referrals to hospital care. This effect is largest for referrals to pediatrics. This study supports the importance of CoC. Even though present developments – more GPs working part-time, higher expectations of GP opening hours – put pressure on CoC, policymakers should invest in this cornerstone of primary care to temper healthcare expenditures.

Competing interests

No funding sources were used to support this study.

The study was conducted in accordance with the regulations of the Medical Ethical Board of University Medical Center Groningen, the Netherlands.

All authors have declared no competing interests.

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CHAPTER 4

THE ASSOCIATION BETWEEN COMORBIDITY AND LENGTH OF HOSPITAL STAY AND COSTS IN TOTAL HIP ARTHROPLASTY PATIENTS: A SYSTEMATIC REVIEW

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ABSTRACT

We performed a systematic review on the relationship between comorbidity and length of hospital stay (LOS) and hospital costs (HC). Electronic databases were systematically searched for relevant studies, conducting methodological quality assessment and best-evidence synthesis: 317 articles were identified, 10 of which fit the inclusion criteria; nine studies determined the relationship between comorbidity and LOS, with eight reporting a positive correlation; five studies were considered to be of high quality, four of which found a positive correlation; two studies analyzed the relationship between comorbidity and HC and reported significantly higher HC for patients with comorbidities, and were considered to be of high quality. In conclusion, there is limited evidence that patient comorbidity has a positive correlation with LOS and HC.

INTRODUCTION

Total hip arthroplasty (THA) is a safe and cost-effective procedure for patients with osteoarthritis of the hip (Chang, Pellisier & Hazen 1996). The prevalence of osteoarthritis of the hip is rising due to an ageing Western society (Jimenez-Garcia et al. 2011, Liu et al. 2009). In addition, there is an increase of patients with obesity, which is also a predisposing factor for osteoarthritis of the hip (Vingard 1991, Holliday et al. 2011, Flugsrud et al. 2006). Both an ageing society and the obesity epidemic cause the number of operative interventions to be on the rise (Otten, van Roermund & Picavet 2010, Ostendorf et al. 2002). There is a vast variety in the characteristics of candidates for THA. Some patients are relatively young and healthy, whereas others can be considered as complex cases, being old and suffering from several comorbid diseases. Due to an ageing society the number of elderly patients and patients with comorbid diseases is on the rise. Increasingly complex patients with multiple comorbidities are found to be eligible for THA and receive an operative intervention (Jimenez-Garcia et al. 2011, Cram et al. 2011). To that end, preoperative work-up and perioperative procedures are ever more adjusted to fit the needs of the individual patient. Additional attempts can be made to improve ward occupation and scheduling of personnel. The financial compensation for THA is approximately equal for each patient, regardless of age, gender or medical history (Geissler et al. 2012, Ellis 1998). This is the case for most European countries, including the Netherlands. The current Dutch financial compensation system does not distinguish patient complexity, hence although a distinction is made between primary diagnosis (e.g. osteoarthrosis, avascular necrosis, fracture) and primary or revision THA, hospitals receive the same amount of compensation for every THA patient, comorbid or not.

Our hypothesis is that complex THA patients with multiple comorbidities have longer length

of hospital stay (LOS), require more diagnoses and therapies, and therefore consume more hospital costs than healthy patients. Insight into these variables could be used to adjust the planning and staffing on the orthopedic wards, and to estimate hospital budgets for THA patients. So far, however, the extent to which there is scientific evidence supporting this hypothesis is not known. To that end, the objective of this study is to conduct a systematic review of the available literature on the relationship between comorbidity and LOS and hospital costs.

METHODS

Studies were searched that reported patient comorbidity and length of hospital stay and/or hospital costs during admission, and which concerned adult patients undergoing primary total hip arthroplasty (THA). We followed the PRISMA statement for conducting and reporting systematic reviews (Moher et al. 2009).

Search strategy and data resources

We conducted a systematic search of publications listed in MEDLINE, EMBASE, and the Cochrane Library between 1 January 1997 and 1 July 2013. We used keywords targeting total hip arthroplasty, comorbidity and comorbidity indices, comorbid diseases, and length of stay and/or costs. The detailed search strategy is presented in Table 1. This search strategy was applied to titles and abstracts, with language restrictions (English and Dutch). The search strategy was formulated and executed by an experienced medical librarian. We also searched for additional articles by viewing cited references of included articles.

Table 1. Search Strategy.

("Arthroplasty,Replacement,Hip"[Mesh]OR"totalhiparthroplasty"[tiab]OR"totalhip replacement"[tiab] OR "hip prosthesis implantation"[tiab]) AND (("Organ Transplantation"[Mesh]) OR (("Immunosuppressive Agents"[Mesh]) OR "Arthritis, Rheumatoid"[Mesh]OR"rheumaticdisease"[tiab]OR"rheumaticdiseases"[tiab]OR"rheumatic disorder"[tiab]) OR (("Mental Disorders"[Mesh] OR anxiety[tiab] OR depression[tiab]) NOT ("Delirium"[Mesh])) OR (("Stomach Diseases"[Mesh]) OR "Esophageal Diseases"[Mesh] OR "stomach dis*"[tiab]) OR ((("Cardiovascular Diseases"[Mesh]) OR ("Diabetes Mellitus"[Mesh]) OR ("Pulmonary Disease, Chronic Obstructive"[Mesh]) OR("heart disease*"[tiab] OR diabetes[tiab] OR "obstructive lung disease*"[tiab])) NOT ("EmbolismandThrombosis"[Mesh]))OR((("Comorbidity"[Mesh]ORcomorbid*[tiab] OR co-morbid*[tiab] OR "Charlson comorbidity index"[tiab] OR ASA-score[tiab] OR ASA-index[tiab])) OR ("index of co-existent disease"))) AND (("Economics"[Mesh] OR "economics"[Subheading])OR(("LengthofStay"[Mesh])OR"PatientDischarge"[Mesh] OR ("length of stay" OR "hospital stay" OR "patient stay" OR discharge OR (stay[tiab] AND hospital[tiab]))))

Inclusion criteria and procedure

Two inclusion criteria were used: 1) The article describes the relationship between comorbidity and length of stay and or costs; and 2) The article describes a separate analysis for total hip arthroplasty patients. Articles were excluded when the study group solely contained revision hip arthroplasty and hip fractures. No exclusion was made on study design and demographic patient data.

After conducting the search as described above, two authors (MO and MS) independently selected eligible articles based on title and abstract. Full-text versions were obtained for all selected articles and these were assessed by the same two review authors (MO and MS) for inclusion. Any disagreement between the two review authors was resolved by consensus, and in case of deadlock by judgment of a third author (IAS).

Methodological quality assessment

Study quality was independently evaluated by two authors (MO and MS) using 14 criteria based on a previously published scoring instrument (Yusuf et al. 2010), with adjustments in terminology to evaluate studies on the association between comorbidity and length of stay and/or costs in THA patients (see Table 2).

Table 2. Quality rating of the selected studies (adapted from Yusuf et al. 2010)

	Criteria
	Study population
1	Sufficient description of characteristics of study groups.
2	The study population is selected at uniform point.
3	There is a clear description of selection of study subjects.
4	Cases and controls were drawn from the same study population.
5	The study cohort equals or is larger than 200 subjects.
6	The participation rate equals or is larger than 80% for study groups.
	Assessment of comorbidity
7	Comorbidity was measured identically for cases and controls.
8	Comorbidity was measured prior to outcome.
	Assessment of costs or length of hospital stay
9	Costs or length of hospital stay were measured identically for cases and controls.
10	A prospective study design was used.
	Analysis and data presentation
11	A distribution of comorbidity is given.
12	Sufficient information on association sizes was given.
13	Appropriate analysis techniques were used.
14	Results were adjusted for age and gender.

This scoring instrument contains criteria about the study population, assessment of comorbidity, assessment of costs/length of stay, and analysis and data presentation. An article scored 1 point when a given criterion was met, otherwise it scored ‘0’. A ‘0’ was also scored when no information was given in the article about the criterion. Differences in assessment were resolved by consensus, and in case of deadlock by judgment of a third author (IAS).

Maximum score obtainable was 14. Studies were regarded to be of high quality when the sum score was 8 or higher, regardless of study type (van Tulder et al. 2003). Studies with a score between 5 and 7 were regarded to be of medium quality, and scores of 4 or lower identified low-quality studies.

Data Analysis

Given the heterogeneity of the included studies and the different statistical tests used, it was not possible to perform a meta-analysis on the data, therefore the results are summarized using a 'best-evidence synthesis' as presented in Table 3. This synthesis makes it possible to rate the evidence of observational studies according to five levels: no evidence, conflicting, limited, moderate or strong evidence (Yusuf et al. 2010, van Tulder et al. 2003, Veenhof et al. 2012). A $P< 0.05$ was considered to be statistically significant.

Table 3. Best-Evidence Synthesis

Strong evidence	Generally consistent findings in multiple high quality cohort studies.
Moderate evidence	Generally consistent findings in one high quality cohort study and ≥2 high quality case–control studies, or in ≥3 high quality case–control studies.
Limited evidence	(Generally consistent) findings in a single cohort study, or in maximum two case–control studies, or in multiple cross-sectional studies.
Conflicting evidence	Less than 75% of the studies reported consistent findings.
Insufficient evidence	Less than two low quality studies available.
No evidence	Provided when no studies could be found.

RESULTS

Article selection

The initial literature search provided 317 articles. Subsequent reading of the titles and abstracts led to exclusion of 295. Full-text was assessed in the remaining 22, then excluding

12 for various reasons, as reported in Figure 1. Overall, 10 studies met the inclusion criteria and were identified as appropriate for this systematic review.

Figure 1. PRISMA flow diagram

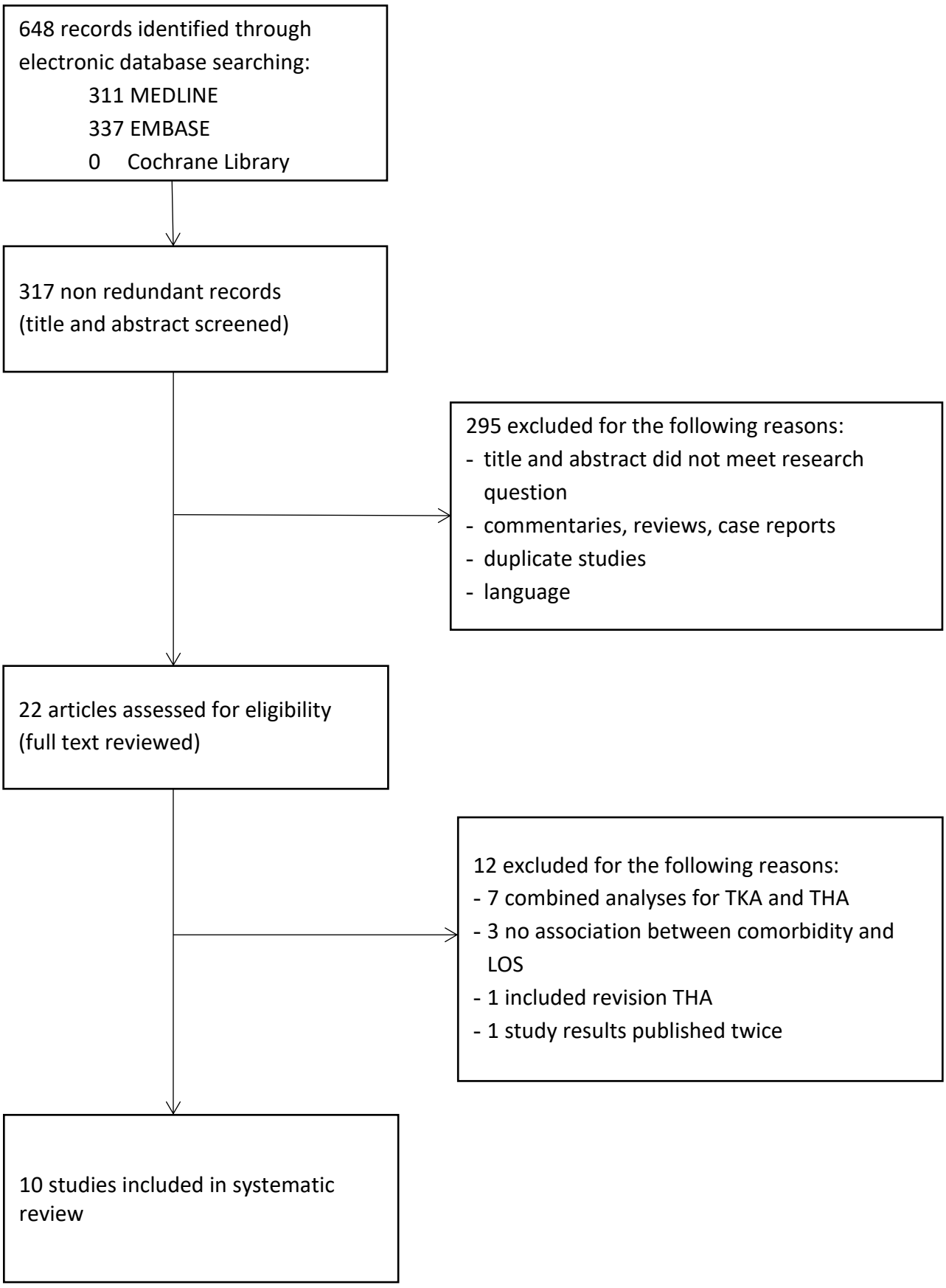

Table 4. Included studies

Author	Method quality score	*n*	Age in years (mean ±SD)	Sex (%fem)	Primary outcome measure	LOS in days (mean)	Costs (mean)	Comorbidity scale (range)	Statistical test	Results
Abbas *et al.* 2011	7	199	-	51.3	LOS	11.8	-	ASA-class (1-4)	LR	OR 6.22 (2.96-13)§
Armitage *et al.* 2010	6	238 999	70.1	61.9	LOS	12.5	-	CCI (0-3)	T-test	CCI 0: 10.9 CCI ≥1: 14.0§
Cullen *et al.* 1994	6	354	64 ± 13	57	LOS	13	-	ASA-class (1-4)	ANOVA	F: 1.8 (ns)
Higuera *et al.* 2011	8	198	74 ± 6.5	62	LOS	-	-	CCI (0-7)	LR	RR 1.1 (1.05-1.56)§
Huang *et al.* 2011	10	9 335	56.8	44.4	LOS	7.8	-	CCI (0-≥2)	LR	CCI 1: 0.59§ CCI ≥2: 1.61§
					Cost	-	-	CCI (0-≥2)	LR	CCI 1: 4068§ CCI ≥2: 14365§
Paterson *et al.* 2010	9	20 290	-	57.5	LOS	-	-	CCI (0-≥2)	LR	CCI 1: 1.19† CCI ≥2: 1.38†
Styron *et al.* 2011	10	40 333	65.8	57.7	LOS	3.9	-	CCI (0-≥2)	LinR	CCI 1: 1.06§ CCI ≥2: 1.17§
Tien *et al.* 2009	10	39 718	-	39.7	Cost	-	$3960	CCI (0-≥2)	MR	CCI 1: 0.01† CCI ≥2: 0.04†
Wang *et al.* 1997	7	65	71	-	LOS	5-39*	-	#comorbidities	ANOVA	<8 days: 1.17 ≥10 days: 2.0†
Weaver *et al.* 2003	9	6 876	62.7	2.6	LOS	10.7	-	ASA class (1-4)	LLR	ASA-2: -0.041†

*= range

LOS = length of stay; LR = logistic regression; LinR: linear regression; MR: multiple regression; LLR: log linear regression

† = $p<0.05$; § = $p< 0.00$; ns = not significant

Description of studies

The 10 included articles only comprised cross-sectional studies. Nine studies used length of hospital stay as primary outcome measure. Two studies included costs as outcome measure (Huang et al. 2011, Tien et al. 2009). Table 4 presents the characteristics of the included studies. Seven studies were published between 2009 and 2011 (Huang et al. 2011, Tien et al. 2009, Abbas et al. 2011, Armitage, van der Meulen 2010, Higuera et al. 2011, Paterson et al. 2010, Styron et al. 2011). Studies with large sample sizes were published throughout the review period, with Amitage (Armitage, van der Meulen 2010) publishing a study of 238,999 patients in 2010 and Styron (Styron et al. 2011) a study of 40,333 patients in 2011.

Methodological quality

A total of six studies were considered to be of high quality (Huang et al. 2011, Tien et al. 2009, Higuera et al. 2011, Paterson et al. 2010, Styron et al. 2011, Weaver et al. 2003), and four studies were categorized to be of medium quality (Abbas et al. 2011, Armitage, van der Meulen 2010, Cullen et al. 1994, Wang et al. 1997).

Demographics

Women represented between 2.6% (veteran study) and 62% of the patients; three articles did not provide these data. A total of five articles did not mention age nor provided mean age of the total population studied. In the other articles age varied between 64 and 74 years. Five studies were conducted in North America (Higuera et al. 2011, Paterson et al. 2010, Styron et al. 2011, Weaver et al. 2003, Cullen et al. 1994), two studies in Taiwan (Huang et al. 2011, Tien et al. 2009), and the remaining three studies were conducted in Pakistan

(Abbas et al. 2011), the United Kingdom (Armitage, van der Meulen 2010) and Australia (Wang et al. 1997).

Comorbidity indexes

All but one study used a comorbidity index as measure for patient comorbidity. Seven studies used the Charlson Comorbidity Index (CCI) to measure patient complexity. The CCI is a valid and reliable tool that classifies comorbidity (Charlson et al. 1987, Hall et al. 2006, de Groot et al. 2003). It scores 19 comorbid conditions at 1-6 points, depending on its severity. Scores range from 0 to 33. Another three studies used the American Society of Anesthetists physical status classification (ASA) to measure patient comorbidity. The ASA classification was designed to assess the preoperative physical status of the patient (Anonymous2013, Davenport et al. 2006). It ranks patients into six groups based on the severity of their comorbid diseases. One study counted the number of medical comorbidities to assess patient comorbidity. No attempt was made to grade the severity of each comorbidity in that study.

Relationship between Comorbidity and LOS

According to the best-evidence synthesis presented in Table 3, limited evidence was found that patient comorbidity has a positive correlation with length of hospital stay after THA. Nine studies analyzed the relationship between comorbidity and length of stay. Five studies were considered to be of high quality and four of medium quality. A wide variety in LOS was reported in these studies, from a mean of 3.9 days up to 13 days. Seven studies reported a significant increase in LOS when patient comorbidity rose a class (in ASA) or a point (in CCI).

One study reported a significant difference in number of comorbidities between the group of patients who stayed in the hospital less than 8 days and those that stayed over 9 days. Four of the five studies that were considered to be of high methodological quality and which used LOS as primary outcome measure used the CCI to determine patient comorbidity, and reported linear or multiple regression models in their statistical analysis. All of these found a significant correlation between comorbidity and length of stay. The one study that used the ASA classification to measure patient comorbidity found shorter length of stays for patients with ASA class 2 compared to ASA class 1.

Relationship between Comorbidity and Costs

Limited evidence was found for the relationship between patient comorbidity and hospital costs. Both studies that determined this relationship were considered to be of high quality. Mean total hospital costs were reported by one study, measuring $3,960 per patient during the period 2002-2004 (Tien et al. 2009). The other study determined hospital costs but did not report average hospital costs per patient (Huang et al. 2011). Both studies used the CCI to determine patient comorbidity, and reported significantly higher costs for patients with a CCI score ≥1 (Huang et al. 2011) and ≥2 (Tien et al. 2009) compared to a CCI score of 0 ($p<0.05$).

DISCUSSION

This systematic review found limited evidence for a positive relationship between patient comorbidity, length of hospital stay and hospital costs. Given that only 10 cross-sectional studies could be included in this review, there is a need for high-quality studies in order to

give a definite answer to the question of whether there is a connection between patient comorbidity and LOS and costs.

Comorbidity and LOS

Limited evidence was found for a positive relationship between patient comorbidity and LOS. Four out of five high-quality studies included in this systematic review found a positive relationship between comorbidity and length of stay. Several factors could explain this relationship. Patients with more serious comorbid diseases could be prone to develop more complications, therefore requiring more medical care. In addition, these patients could be less independent than healthier patients and thus require a longer recovery period to return to their original level of independence. It seems self-evident that these patients require longer hospital stay. Since almost all studies point in that same direction, it can indeed be concluded that based on the current literature comorbidity has a prolonging effect on LOS, although evidence is limited due to the low number of studies and reduced amount of high methodological quality studies.

Patient comorbidity was determined using ASA score, CCI, or counting the number of chronic comorbidities. These measures provide rough estimates of the preoperative health status of patients. However, patients vary vastly in the burden they experience from their comorbidities. Having diabetes mellitus does not have the same impact on every patient, depending for example on how well it is regulated. A combination of the ASA score, which assesses the health status of patients, and the CCI, which determines the presence of comorbidities, would provide better insight into the health burden that patients experience from their comorbidities.

Although four out of five high-quality studies point in the same direction, one study found a shorter length of hospital stay for patients with an ASA score of 2 compared to 1. However, the parameter estimate for this difference was only small (-0.041). Higher ASA scores did not lead to significant differences in length of stay. Since patients that fall into ASA class 2 tend to be relatively healthy, only suffer from minor comorbidities and only use a few chronic prescriptions, they do not differ notably from patients in ASA class 1. This specific study did however show that patients suffering from diabetes or COPD or with a history of CVA had longer hospital stays. These more serious conditions are likely to lead to higher ASA scores, and it seems unlikely that these patients were scored in ASA class 2. Two other studies of lower quality that used ASA scores to determine patient comorbidity (Abbas et al. 2011, Cullen et al. 1994) found a positive relationship between higher ASA scores and length of stay.

In the included studies, LOS is straightforwardly determined by calculating the difference between the admission and discharge date per patient. It should be noted that the included studies did not report the place that the patient was transferred to after the THA. Some patients were discharged to go home, whereas others would have continued their rehabilitation process at a nursing home or a specialized rehabilitation center. Patients who rehabilitate at home require more independence in their mobility than those who are transferred to specialized centers or nursing homes. Hence the discharge location potentially has vast effects on length of hospital stay, and could therefore be a confounder in the results.

Comorbidity and Costs

This systematic review found limited evidence that patients with more comorbidity cause hospital costs to be higher as opposed to patients with no or fewer comorbidities. This can be logically explained by the fact that patients with comorbid diseases tend to develop more complications, therefore requiring more diagnostics and therapies, and have longer LOS, all of which result in higher hospital costs.

Evidence is limited, as costs have been calculated in only two studies. Moreover, costs were calculated in different ways. One study used the reimbursement from the national health care insurer (Tien et al. 2009), the other did not provide information on how it calculated costs (Huang et al. 2011). An explanation can be that determining hospital costs for a specific surgical intervention such as THA is a complex process. Choosing which costs do or do not make up part of the total costs can create significant differences in the hospital charges for THA. For some expenses, such as debit costs, it is difficult to determine what amount can be ascribed to an intervention. This makes the reported hospital costs in this systematic review incomprehensible; it is therefore impossible to compare reported costs of the two included studies. Only studies that clearly report how hospital costs are built up could potentially generate unbiased results, and only studies that use the same cost calculation can be compared with each other.

Comorbidity indexes

Regarding the assessment of comorbidity too, studies used different measures, which makes it hard to compare studies. The included articles used the Charlson Comorbidity Index, the ASA classification system, and number of comorbidities as a measure for comorbidity of THA patients. These tools all have both positive and negative features. The CCI is used frequently

as a tool to measure patient comorbidity in THA studies (Bjorgul, Novicoff & Saleh 2010). The validity of the CCI has been confirmed by several studies (de Groot et al. 2003), and its reliability has previously been shown to be excellent (Hall et al. 2006). However, the CCI might be a poor predictor of quality of life after THA, possibly because it focuses on life-threatening diseases rather than on functional outcome (Harse, Holman 2005). The ASA classification is widely used as a standard preoperative measurement and is therefore readily available (Davenport et al. 2006). It also has been used multiple times as a measure for comorbidity in THA studies (Bjorgul, Novicoff & Saleh 2010), yet lacks precision and its interpersonal reliability is questionable (Aronson, McAuliffe & Miller 2003, Mak et al. 2002, Ranta, Hynynen & Tammisto 1997). Counting the number of comorbidities is an easy and straightforward way to measure comorbidity. It has been proven to be a valid measure (Rochon et al. 1996, Gross et al. 1991), but not specifically for THA patients. In addition, previous research shows that counting the number of comorbid diseases appeared to be less reliable then the CCI (de Groot et al. 2003).There is, however, no benchmark as to which comorbidities should be included in the count. The study in this review that counted the number of comorbidities (Wang et al. 1997) did not provide an explanation on how it determined which diagnoses were included in the count. In conclusion, both the CCI and the ASA classification appear to be reliable and valid tools to measure comorbidity, although both have their specific shortcomings. Counting the number of comorbidities seems to be a less reliable tool. Since the high methodological quality studies in this systematic review all used the CCI, it can be assumed that comorbidity was determined in a valid manner. This also facilitates the comparability of these high-quality studies.

Limitations

This systematic review was limited by significant heterogeneity in study methodology and a lack of high-quality prospective cohort studies. Specifically, only 10 cross-sectional studies could be included. In addition, only studies published in English and Dutch were included, as a result of which high-quality studies may have not been included in this systematic review. Studies varied greatly in age and gender of included patients. The number of included patients varied from low (65) to very high (>200 000). Length of stay was also highly variable in the included 10 studies. All this may have led to incomparability of the results of the included studies.

Conclusions

This systematic review found limited evidence for a positive relationship between patient comorbidity and LOS and costs. Four high methodological quality articles in this review showed that more complex patients will have on average a longer hospital stay. Comorbidity was measured using the CCI and the ASA classification, which are reliable measuring methods. Since only two studies determined hospital costs for THA patients, and the techniques of both studies to analyze costs differ substantially, this systematic review only gives limited evidence for the correlation between hospital costs and comorbidity.

Future research perspectives

Methodological high quality studies are needed to provide more evidence for the relationship between comorbidity and LOS and costs among THA patients. Ideally, this connection should be studied with the aid of different comorbidity indexes in large prospective cohort studies, to ensure that comorbidity indexes have no confounding effect.

Furthermore, there is a need for studies that clearly report the assessment of hospital costs for THA patients, which would facilitate comparability with other cost studies. And last, it would be interesting to assess the relationship between comorbidity and LOS and costs of Total Knee Arthroplasty (TKA) patients, as this procedure has a much greater impact on the health status of patients.

This systematic review shows that there is a lack of high-quality information on the relationship between comorbidity, LOS and costs. Knowledge on this topic would not only provide insight into the LOS and costs of patients, but would also support better preoperative risk stratification of THA patients. In that way, the quality of care can be improved, given that patients will be better prepared for their procedure and complications can be anticipated.

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CHAPTER 5

MEDICATION USE IS A BETTER PREDICTOR OF LENGTH OF HOSPITAL STAY IN TOTAL HIP ARTHROPLASTY THAN THE AMERICAN SOCIETY OF ANESTHESISTS (ASA) SCORE

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ABSTRACT

Background

Length of hospital stay (LOS) greatly influences costs of total hip arthroplasty (THA). LOS is, amongst others, dependent on patient comorbidity. ASA scores are traditionally used as comorbidity measure, but simple medication-based measures may suffice. Therefore the objective of the study is to determine if medication based measures (count of medication and the medication-based index CDS) have a surplus value compared to a diagnosis-based measure for comorbidity (ASA score) to predict LOS in THA.

Methods

A retrospective cohort study. THA patients from three hospitals were included for 2009-2013, and demographic data, comorbidity (ASA score) and medication use (count of medication and CDS) was collected. A binomial regression model was used to compare the predictive ability of the medication-based and diagnosis-based measures.

Results

2.282 THA patients were included. Number of medications proved a statistical significant predictor of LOS. LOS increased 6% (IRR: 10.06 (CI: 1.03-1.09)) with each medication. Neither the CDS nor the ASA score had a statistically significant relation to LOS.

Conclusion

The medication-based measure *count of medication* is a better predictor for LOS in THA than the CDS and ASA score. This simple measure also appears to have more clinical relevance, as it has a higher range in scores than diagnosis-based indexes and is easily applicable.

INTRODUCTION

As the population in Western society ages, the prevalence of osteoarthritis rises. Increasing numbers of patients suffer from hip osteoarthritis and want to undergo a total hip arthroplasty (THA)(Cram et al. 2011, Jimenez-Garcıa et al. 2011). In addition, complex patients with multiple comorbidities and/or a higher body mass index (BMI) are more easily accepted for THA than in earlier days(Cram et al. 2011, Jimenez-Garcıa et al. 2011, Maradit Kremers et al. 2014). THA therefore puts an increasing burden on the healthcare budget. The length of hospital stay (LOS) of THA patients has declined over recent decades, but it still makes up for a majority of the costs of THA. LOS is related to several patient characteristics. Literature reports that age, sex(Abbas et al. 2011, Inneh, Lewis & Schutzer 2014) and comorbidity(Olthof et al. 2014, Elings et al. 2014) are important predictors of LOS after THA. There are several methods to assess comorbidity. A frequently-used method is a diagnosis-based measure, such as the American Society of Anesthetists (ASA) score or the Charlson Comorbidity Index (CCI). An alternative measure for comorbidity is a medication-based index.

A recent systematic review found that diagnosis-based measures have a greater ability to predict mortality outcomes(Farley, Harley & Devine 2006), but that medication-based measures predict healthcare utilization(Yurkovich et al. 2015) such as LOS(Parker, McCombs & Graddy 2003) and hospital costs better. Overall, two general methods have been used as a medication-based measure: a simple count of the number of medications and a medication-based index with weighted scores. Medication-based measures are relatively new in arthroplasty research. Whether a medication-based or a diagnosis-based measure is better at predicting LOS for THA still has to be determined. One study by Dietrich(Dietrich et al. 2015) found a positive relation between LOS and number and type of medication, but this

has not been confirmed by other studies. The authors of this study did not use a medication-based index as predictor of LOS, which could also have more predictive value as it incorporates weighed scores.

For these reasons, the objective of the present study is to compare the predictive ability of two medication-based measures (a count of the number of medications and a medication-based index) and a diagnosis-based measure for the LOS of THA patients.

METHODS

Design

This is a retrospective cohort study that compares the predictive value of two medication-based measures and one diagnosis-based index. Patient data from two academic hospitals and one large, general hospital in the Netherlands were collected in retrospect for 2009-2013. Patients were identified using the Diagnosis Therapy Code (DTC) for unilateral hip arthrosis with joint replacement**.** Patients that were operated on both sides during the study period were included separately for each admission. Patients who received a THA after a hip fracture, patients with malignancies in the hip and patients with congenital hip dysplasia were excluded. The study was conducted in accordance with the regulations of the Medical Ethical Board (*no.* METc2013.431).

Data sources

Demographic patient data, ASA classification and length of hospital stay were electronically generated from the electronic databases of each hospital. Length of stay was measured in whole days from admission to discharge. Number and type of medication was either automatically or manually collected from the hospital pharmacy database. When no data

was available, we used the preoperative screening document as the source of medication. Medication prescribed by THA protocol was eliminated from the medication lists. These medications included antibiotics, analgesics, antiemetics, antacids and subcutaneous anticoagulants. All medication was coded into therapeutic classes (e.g. ACE inhibitors, insulin and oral corticosteroids).

Measurement instruments

To assess comorbidity, two medication-based measures and one diagnosis-based index were used: the count of the number of medications and a medication-based index, the Chronic Disease Score (CDS). The count of medications included all types of prescribed medications, ranging from vitamins to oral chemotherapy. When a patient used more than one medication from the same therapeutic group (e.g. different types of insulin or more than one type of benzodiazepine), every separate drug was counted.

The CDS is a medication-based index developed to predict the utilization of healthcare services such as hospitalization, physician visits(Schneeweiss et al. 2001), costs(Farley, Harley & Devine 2006) and LOS(Parker, McCombs & Graddy 2003). It was originally created by von Korff (Von Korff, Wagner & Saunders 1992) and refined by Clark(Clark et al. 1995). The CDS in this study was calculated with the aid of the general procedure described by Clark(Clark et al. 1995). Patients were screened for the occurrence of therapeutic groups listed in the CDS, and the CDS score was calculated.

The American Society of Anesthetists (ASA) physical status classification is a diagnosis-based index designed to assess the preoperative physical status of a patient(Davenport et al. 2006, ASA classification 2013). It categorizes patients into six groups based on the presence and severity of their medical conditions.

Statistical analysis

Descriptive statistics were used to analyze demographic patient characteristics (sex and age) and LOS. Since the primary outcome LOS was not normally distributed, and there was evidence of overdispersion of data, we performed a negative binomial regression analysis to determine the relation between LOS and patient characteristics, medication count, CDS and ASA classification. Age, medication count, CDS and ASA classification were included as interval variables. Sex was included as a nominal variable. Incidence rate ratios (IRR) and confidence intervals were calculated. The IRR represents the change in the dependent variable when the independent variable changes one unit (for interval or continuous data) or changes compared to the reference category (for nominal data).

The model was programmed to correct results for the influence of individual hospitals. A model with patient age and sex was used. Medication count, CDS and ASA classification were individually added and analyzed for their predictive value on LOS. All statistical analyses were performed using SPSS 20.0 with a significance level of $p<0.05$.

RESULTS

Patient characteristics

A total of 2.282 patients were included. An overview of the patient characteristics is presented in Table 1. Of all patients, 60.1% received a THA in the general hospital and the remainder in the two academic hospitals. Most patients had an ASA class II. The number of medications used showed great variety, with 16.2% of patients (n=396) using no medication at all.

Table 1. Patient characteristics (n=2,282)

Gender (M/F)	743/1539 (32.6/67.4)	
Age (years)	66.8 (12.5)	
Hospital	General hospital: 1371 (60.1)	
	Academic hospital: 911 (39.9)	
ASA class	I Healthy: 305 (13.4)	
	II Mild systemic disease: 1412 (61.9)	
	III Severe systemic disease: 555 (24.3)	
	IV Life-threatening: 10 (0.4)	
Length of stay (days)	8.4 (5.7)	Range: 2-83
Number of medications	3.7 (3.2)	Range: 0-32
CDS (0-28)	2.2 (1.9)	Range: 0-10

ASA class: American Society of Anesthetists classification; CDS: Chronic Disease Score.
Data are presented as Mean (Standard Deviation) or Count (%)

Diagnosis-based and medication-based index

The regression model comparing the two medication-based measures (number of medications, CDS) with the diagnosis-based index (ASA classification) on their predictive ability for LOS is presented in table 2. Females and older people have on average a longer LOS. Patients with a higher count of medication have a longer LOS, which is the only statistically significant predictor. The results show that LOS increases 6% with each additional medication (IRR: 1.06 (CI: 1.03-1.09)). A lower CDS score and a higher ASA score are associated with a longer LOS, but this relation is not statistically significant.

Table 2. Association between length of stay and patient characteristics, corrected for hospital

	IRR	95% Confidence Interval	p-level
Sex (male)	0.932	0.848 to 1.025	0.146
Age (years)	1.002	0.998 to 1.006	0.321
ASA class	1.050	0.963 to 1.143	0.268
Number of medications	1.059	1.028 to 1.091	<0.000
CDS	0.967	0.921 to 1.016	0.182

IRR: Incidence Rate Ratio; ASA class: American Society of Anesthetists classification; CDS: Chronic Disease Score

DISCUSSION

In this study we found that the number of preoperative medications that a patient uses is the strongest predictor of LOS after THA. Females, older patients, and patients with lower CDS scores and higher ASA scores appear to have a longer LOS, but these factors were not statistically significant.

The result that a medication-based measure is a better predictor for LOS than a diagnosis-based index is in line with previous research (Yurkovich et al. 2015),(Dietrich et al. 2015). However, our study only found a relation with number of medications and not with the medication-based index CDS. One possible explanation is that the number of medications is a better reflection of the severity of the disease than a diagnosis-based index such as the ASA score or a medication-based index like the CDS. The CDS, for example, has only one measure for Chronic Obstructive Pulmonary Disease (COPD): the patient either suffers from the illness or not. But whether the patient uses four different types of medications for COPD or just one, adds information about the severity of the disease. The same is true for diabetes, cardiovascular disease, mental illness and all other chronic or non-chronic diseases. The CDS only expresses the presence of a disease and not its severity.

A second explanation is that the count of medication has a much larger scale than the diagnosis-based indexes and the CDS. The ASA classification has six scales, but only four scales are used in THA. The CDS theoretically has a range of 0 to 28. In our study CDS scores varied from 0 to 10. The number of medications ranged from 0 to 32, which can be the reason why it expresses differences in complexity of patients better. Hence because it may be better aligned with a patient's disease severity, the number of medications may provide a better reflection of the complexity of the patient than a diagnosis-based index or the CDS. This greater variance also grants more clinical relevance to the medication count. For example, the difference between a patient that uses no medication and a patient that takes 10 types of medications has a marked influence on the length of hospital stay, but the difference in one ASA class only makes a small difference.

This study also found a non-significant relation between a longer LOS and female sex and older age. This result is in line with previous literature, where these demographic patient characteristics were found to be of statistically significant influence on LOS(Abbas et al. 2011, Inneh, Lewis & Schutzer 2014).

Strengths and limitations

A strong point of the study was that we included patients from three consecutive years at three different hospitals, academic as well as non-academic. This allowed us to include a mixed patient population that can be considered a good reflection of the general population. Our study consists of more than 2000 patients, which is much larger than a previous study with a similar research objective(Dietrich et al. 2015). We also included only electronically registered data, which is considered the most reliable source of information. Unfortunately we were unable to obtain a CCI from the electronic patient register, so we could not

compare the CCI of patients with the medication-based measures. We were also unable to distinguish between medication prescribed by protocol prior to the THA and previous medication use. Pain medication, for example, had to be eliminated from the analysis to prevent distortion of the data, as described in the Methods section. Inclusion of these medications may have contributed to an even better predictive ability of the medication count measure. The range of medication use would have been larger and it would have given better expression to the severity of patients' comorbid illnesses.

A limitation of the study is the average LOS of 8.4 days. Compared to the LOS in today's often used fast track surgery programs, this LOS can be considered long. During the study period, fast track programs were not yet running in the Netherlands. The discharge criteria were based on general accepted recommendations in the Netherlands at the time: the ability to walk (with crutches), and the ability to get in and out of bed and chair independently. These criteria did not differ significantly between the participating hospitals. In addition discharge criteria did not differ between patients going home or to an extended care facility (ECF). To qualify for an ECF, it was more important whether the patient has a spouse or caregiver at home, or whether the home situation is safe to rehabilitate. The participating hospitals all had arrangements with ECF's with respect to the immediate transfer of patients fulfilling the discharge criteria, however in some cases there could have been some delay due to capacity or administrative procedures. Consequently the results of this study cannot automatically be generalized to settings using fast track surgery. However our clinical impression, after adopting functional discharge criteria and having reduced LOS, is that the results of our study are still valid. This needs further study though.

Another limitation is that we only studied a small number of factors that influence LOS. Other factors that are also of (potential) influence are related to the patient (f.e. other

physical, mental or cultural factors, discharge destination), the physician (f.e. experience), and the hospital (f.e. large versus small number of procedures per year).

Implications for the future

This is one of the first studies to compare the predictive value of medication-based measures for LOS after THA to a diagnosis-based measure. We found that a simple count of the number of medications has the best predictive power for LOS. Even though the difference between the IRR of the count of medication was only slightly higher than the ASA score, the count of medication has a much greater clinical relevance. This finding opens up a new world for the field of analysis of LOS for common surgical procedures. Future research could further analyze this relation, specifically its value in direct comparison with other comorbidity indexes, and for other non-orthopedic and orthopedic procedures, such as Total Knee Arthroplasty (TKA).

Potentially, these studies can contribute to a better model to predict LOS after THA. A reliable preoperative prediction of the LOS of patients can help improve the workload and logistics at the orthopedic ward and can minimize unoccupied hospital beds. It can also contribute to a more realistic financial compensation for THA for hospitals. All these adjustments can reduce the burden that THA puts on the healthcare budget.

Conclusion

This study found that the number of medications used prior to THA has a better predictive value for length of hospital stay than a diagnosis-based and medication-based index. This simple measure also appears to have more clinical relevance, as it has a higher range in scores than diagnosis-based indexes and is easily applicable.

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CHAPTER 6

ACTUAL AND PERCEIVED NURSING WORKLOAD AND THE COMPLEXITY OF PATIENTS WITH TOTAL HIP ARTHROPLASTY

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ABSTRACT

Background

Little is known about the relation between patient complexity and nursing care of total hip arthroplasty (THA) patients. To improve patient care and hospital logistics, the aim of this study is to gain insight into the relation between patient complexity and the actual workload and the workload perceived by the nursing staff at an orthopedic ward during admission for a THA.

Design

Prospective cohort study of 45 THA patients in the year 2014. Duration and type of nursing care activities were recorded during the first postoperative morning. A questionnaire was used to analyze the perceived workload of the nursing staff. Both actual and perceived workload were analyzed for their relation with patient complexity, expressed in the American Society of Anesthesiologists (ASA) score, Charlson comorbidity index (CCI)), Katz Activities of Daily Life score and Body Mass Index (BMI).

Results

No relation was found between actual workload and measures for patient complexity. The perceived workload of the nursing staff was related to two complexity measures: ASA ($r = 0.71$; $p < 0.001$) and CCI ($r = 0.65$; $p = 0.002$).

Conclusion

Patient comorbidity is related to the perceived workload of the nursing staff during admission for a THA. Patient complexity is not related to actual workload. This study gives a first insight into the relation between patient comorbidity and nursing staff workload, to try to improve staffing numbers at the ward as well as improve patient care in the process.

INTRODUCTION

Each year an increasing number of patients undergo a total hip arthroplasty (THA) (Otten, van Roermund & Picavet 2010, Hooper et al. 2014). Due to an ageing society, more older patients are operated on (Otten, van Roermund & Picavet 2010, Hooper et al. 2014), and this also includes more complex patients with several comorbid diseases. To get an indication of patient complexity, several comorbidity measures (e.g. Charlson Comorbidity Index (CCI) (Charlson et al. 1987, Higuera et al. 2011), American Society of Anesthesiologists (ASA) score (ASA Classification 2013, Elings et al. 2014)) as well as other instruments (e.g. Katz Activities of Daily Living (ADL) score (van Aalst et al. 2014), Body Mass Index (BMI)) (Maradit Kremers et al. 2014, Kim 2010) can be used.

In general, complex patients have a longer length of hospital stay and generate higher hospital costs (Olthof et al. 2014). These costs could be the result of added nursing care and interventions during admission. Ample literature is available that analyzes the relation between patient complexity and nursing care during admission for a THA. Only one study has demonstrated a relation between patient comorbidity – as a measure for patient complexity – and number of nursing activities during hospital stay for THA (Lee, Moorhead 2014). However there is no literature analyzing the relation between patient complexity and actual workload of the nursing staff.

When patient complexity is related to the amount and type of nursing care, hospital logistics (e.g. operation planning, staffing numbers) can be adjusted to it. The relation between patient complexity and perceived workload of the nursing staff is also unknown. Although the amount of work can be the same, nursing staff can experience a much higher workload with complex patients, which can include more responsibilities. A higher perceived workload

can result in more work-related stress, eventually leading to a higher rate of absenteeism (Davey et al. 2009, Zangaro, Soeken 2007).

The objective of this study is therefore to gain insight into the relation between patient complexity and nursing care for THA patients. First, it is examined whether patient complexity is related to the duration of the work of the nursing staff at the orthopedic ward. The relation between patient complexity and perceived workload of the nursing staff is subsequently analyzed. It is hypothesized that a higher patient complexity is related to nursing staff spending more time on patient care and perceiving a higher workload.

THE STUDY

Aim

The aim of this study was to gain insight into the relation between nursing staff workload, both actual and perceived, and the complexity of patients receiving a total hip arthroplasty.

Design

In a prospective time-and-motion study (Pelletier, Duffield 2003), patients were observed by a medical student on the ward on the morning of the first postoperative day (from 07:15 to 12:00 AM). The rationale for the choice of this time period is that it is considered to be when differences in nursing care would first stand out. Since patients have to become more active, especially during ADL activities in the morning of their first postoperative day and regardless of operation time the previous day, differences between complex and less complex patients were hypothesized to be present. All activities provided to the patient on the ward by nursing staff were recorded and divided into six categories: Medical-technical tasks,

Communication, Transportation, Eating/Drinking, Activities Of Daily Living (ADL) and Other. The data were collected during February 2014 and July 2014.

Participants

A sample of THA patients was recruited from both a large general hospital and an academic hospital in order to ensure a mix of patients with different grades of complexity. Inclusion in the study was based on the following requirements: the patient was willing to participate in the study; the first postoperative day had to be on a weekday; and the observer was available for both the day of inclusion (preoperative day) and the first postoperative day. All patients that met these criteria were included.

Data collection

We collected demographic patient data (age and sex), patient complexity data and length of stay (LOS) using patients' records. Patient complexity was measured with the aid of several instruments that are related to LOS after THA (Olthof et al. 2014). The first tool is the widely used American Society of Anesthesiologists (ASA) score, to assess patients' preoperative physical status. It ranks patients into six groups based on the severity of their comorbid diseases (Anonymous2013, Davenport et al. 2006). The second tool is the Charlson Comorbidity Index (CCI). The CCI is a valid and reliable tool that classifies comorbidity. It scores 19 comorbid conditions at 1-6 points, depending on severity (Charlson et al. 1987, Hall et al. 2006, de Groot et al. 2003). For this study we calculated the CCI using the Royal College of Surgeons (RCS) method, as presented previously in literature (Armitage, van der Meulen 2010). The third tool, the Katz ADL score, measures patients' independence in activities of daily living. A patient who can perform all Activities of Daily Life (ADL)

independently scores category A. For every additional ADL that requires assistance, the patient scores a lower category (van Aalst et al. 2014). The fourth tool is Body Mass Index (BMI), a measure of weight compared to height (Maradit Kremers et al. 2014). The ASA score was extracted from the preoperative screening form. The CCI and the BMI were calculated by the observer. The KATZ-ADL was derived from the admission form.

We also used a self-developed questionnaire to assess perception of workload by the nursing staff during the same part of the day that their activities were observed. This questionnaire listed the same six categories of nursing activities. The categories could be rated with “low”, “average” or “high” intensity. The percentage of categories scoring “high” was used as a measure of workload intensity. The questionnaire is presented in Appendix A.

Ethical considerations

The study was conducted in accordance with the regulations of the Medical Ethical Board of our institution (METc 2012.412).

Data analysis

The relation between the indicators of patient complexity and both duration of work and perceived workload was analyzed using the Pearson correlation test for scale data (BMI and CCI) and the Spearman rho test for ordinal data (ASA score and Katz ADL). The following cut-off points for correlation coefficients were used: 0.00-0.25, very weak; 0.26-0.49, weak; 0.50-0.69, moderate; 0.70-0.89, strong; 0.90-1.00, very strong (Domholdt 2000). All data was analyzed using SPSS 20.0, and differences in p-values < 0.05 were considered to be significant.

RESULTS

A total of 45 patients who received a THA in either the academic or the general hospital were included. Patients were on average 67.4 years old (SD 8.7). The population included 64% females. Average LOS was 6.0 days (SD 4.2) for the entire study population – 8.9 days at the academic hospital and 3.1 days at the general hospital. All patient characteristics are presented in Table 1.

On average, nursing staff provided 70 (SD 21.4) minutes of direct patient care the morning of the first postoperative day (67 (SD 20.8) minutes at the academic hospital and 72 (SD 22.7) minutes at the general hospital). The most time was spent on Medical-technical tasks (39 minutes (SD 11.3)) and ADL (19 minutes (SD 9.9)). Time spent on Communication (3 minutes (SD 2.9)), Transportation (3 minutes (SD 10.8)), Eating/Drinking (2 minutes (SD 1.0)) and Other (3 minutes (SD 2.4)) was less (see Table 2 for a list of nursing activities per category).

The relations between workload and patient complexity are presented in Table 3. No statistically significant relation was found between the measures of patient complexity and amount of time spent on direct patient care. The workload perceived by the nursing staff showed a strong correlation with the ASA score, a moderate correlation with the CCI and no statistically significant correlation with BMI or the Katz ADL score.

Table 1. Patient characteristics (n=45)

Age	67.4 (8.7)
Sex (female)	29 (64.4 %)
ASA classification	
I. Healthy	7 (15.5%)
II. Mild systemic disease	26 (57.8%)
III. Severe systemic disease	12 (26.7%)
Charlson Comorbidity Index	
0	19 (42.2%)
1	12 (26.7%)
2	9 (20.0%)
3	2 (4.4%)
>4	3 (6.7%)
BMI	28.6 (3.6)
KATZ ADL score	
A	1 (2.2%)
B	3 (6.7%)
C	8 (17.8%)
D	9 (20.0%)
E	18 (40.0%)
F	4 (8.9%)
G	2 (4.4%)

Results in mean (SD) or n (%). ASA: American Society of Anesthesiologists; BMI: body mass index; ADL: activities of daily life.

Table 2. Overview of nursing activities

Category	Nursing activities
Communication	Communication with patient/family
	Emotional support
	Anamnesis
	Explanation/instruction to the patient
Medical technical tasks	Measuring vital parameters (blood pressure, temperature, pulse)
	Measuring fluids
	Accompanying physicians' visit to the patient
	Documentation of patient record
	Preparing and supplying medication
	Wound and skin care
	Catheter care
	Infusion therapy
Transportation	Transportation to radiology
	Transportation to other departments
ADL	Helping with toilet visit / emptying urinal container
	Changing clothes and bed sheets
	Changing position on the bed
	Washing patient on the bed or in the shower
	Dental care / combing hair / shaving, etc.
Eating and drinking	Providing food and drink, help with eating and drinking, cleaning up.
Other	Other activities not mentioned above

ADL: activities of daily living

Table 3. Relation between patient complexity measures and workload (perceived and in time) (n=45)

Patient complexity measures	Workload in time	Perceived workload
ASA score**	-0.208 (ns)	0.711 (p<0.001)
CCI*	-0.063 (ns)	0.651 (p=0.002)
BMI*	0.018 (ns)	0.323 (ns)
Katz ADL**	-0.096 (ns)	0.379 (ns)

*ASA: American Society of Anesthesiologists; CCI: Charlson comorbidity index; BMI: body mass index; ADL: activities of daily living; ns: not significant. * Pearson correlation; ** Spearman's rho*

DISCUSSION

In this study we wanted to gain insight into whether patient complexity can be used as a measure for the workload of nursing staff when it comes to care after total hip arthroplasty. We found no statistically significant relation between patient complexity and actual workload. However, two of the patient complexity measures, ASA score and CCI, were related to a higher perceived workload.

There are several explanations for these results. First, patient complexity may be unrelated to the actual workload of nursing staff in time, because nursing care does not differ strongly across patients on the first postoperative day. At that moment, complex patients might not require as much additional care as we hypothesized. Had the observations lasted beyond that first postoperative day, more profound differences between low- and high-complexity patients may have been found.

Second, other factors could be more influential to the workload of nursing staff, such as a patient's personality, patients' expectations and beliefs about nursing care, or the culture and organization of care of the hospital. Especially the last factor could have had a major

influence on our findings. As the average LOS of patients is 8.9 days at an academic hospital and 3.1 days at a general hospital, personnel at an academic hospital has more days to spread nursing activities than general hospital staff. In this way not only patient characteristics but also the organization of care could have had a major influence on the outcomes of our study. The availability of nursing personnel is another potential factor that needs further study.

On the other hand, the nursing staff did perceive more workload when patients had higher scores on the ASA and CCI. Even though more complex patients did not cause more actual workload, the burden felt by the personnel was higher. This could be explained by both the physical and psychological aspects of the job. Although the same amount of time is spent per patient, complex patients can require heavier physical efforts because they are less ADL-independent. The psychological or emotional aspect of the job can also be more demanding, as nursing staff can feel the burden of increased responsibilities when it comes to monitoring the health of complex patients.

A third explanation for the found results is that the chosen measures for complexity as well as for the workload may not have been specific enough. The ASA score, CCI, Katz ADL score and BMI were used to measure complexity in the current study; other options that require further investigation are socioeconomic status, medication usage, and mental and functional capability tests.

The relation between ASA score and actual workload was negative yet small, possibly due to the more serious comorbidities of patients with high ASA scores and their higher need to stay in bed on the first postoperative day. This possible explanation is substantiated by the results of the Katz-ADL score, which were also found to be slightly negative.

To our knowledge, this study is the first to use time as a measure of the workload of orthopedic ward nursing staff working with THA patients. This type of research is innovative, as it tries to provide insight into the work processes and workload on the ward. Only Lee and Moorhead have conducted a study like ours, and they found that patient comorbidity was related to the number of nursing care activities (Lee, Moorhead 2014). However, these authors used standardized lengths for nursing activities that were digitally recorded. Other similar studies only analyzed cost-effectiveness and not workload (Lee, Moorhead & Clancy 2014, Titler et al. 2007). We measured actual bedside time using a time-and-motion observation method and measured the perceived workload of the nursing staff.

Strengths and limitations

Strengths of this study are the thorough observations using a standardized method of the actual bedside activities per patient, and the inclusion of patients with different grades of complexity. Limitations are the observation bias (the presence of an observer may have influenced the behavior of the nursing staff), the small study sample, and the bias of organizational differences between the two hospitals.

Conclusion

In this study we did not find a relation between patient complexity and the actual workload of the nursing staff measured in time during the hospital stay of THA patients. We did however find a relation between patient complexity and perceived workload of the nursing staff. This study provides a first insight into the relation between patient comorbidity and workload of nursing staff, aiming at improving staffing numbers in the ward as well as patient care in the process.

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Appendix A. Questionnaire for perceived workload

Nurse: ……..

Patient: ……

Date: ……

Please provide your perceived workload per activity that you provided to the above-mentioned patient on the above-mentioned day.

Category		Intensity
Communication	Communication with patient/family	**Low Moderate High**
	Emotional support	**Low Moderate High**
	Anamnesis	**Low Moderate High**
	Explanation/instruction to the patient	**Low Moderate High**
Medical-technical tasks	Measuring vital parameters (blood pressure, temperature, pulse)	**Low Moderate High**
	Measuring fluids	**Low Moderate High**
	Accompanying physicians' visit to the patient	**Low Moderate High**
	Documentation of patient record	**Low Moderate High**
	Preparing and supplying medication	**Low Moderate High**
	Wound and skin care	**Low Moderate High**
	Catheter care	**Low Moderate High**
	Infusion therapy	**Low Moderate High**
Transportation	Transportation to radiology	**Low Moderate High**
	Transportation to other departments	**Low Moderate High**
ADL	Helping with toilet visit / emptying urinal container	**Low Moderate High**
	Changing clothes and bed sheets	**Low Moderate High**
	Changing position on the bed	**Low Moderate High**
	Washing patient on the bed or in the shower	**Low Moderate High**
	Dental care / combing hair / shaving, etc.	**Low Moderate High**
Eating and drinking	Providing and helping with eating and drinking, cleaning up.	**Low Moderate High**
Other	Other activities that are not mentioned above	**Low Moderate High**

CHAPTER 7

GENERAL DISCUSSION

GENERAL DISCUSSION

The aim of this thesis was to elaborate on the knowledge regarding which patient characteristics are related to healthcare consumption. Identification of these patient characteristics is the first step towards a differentiated capitation model. The sub-questions of the thesis were:

1. *Which patient characteristics are related to healthcare consumption in the primary care sector in the Netherlands?*
2. *Which patient characteristics are related to healthcare consumption in the hospital sector in the Netherlands?*

The thesis was structured in two parts: primary care and hospital care. In Chapters 2 and 3 the relation between patient characteristics and healthcare consumption in the primary care sector was analyzed (sub-question 1). In Chapter 2 it was found that patient comorbidity was strongly related to the number of consultations and visits with the GP – a measure for healthcare consumption. In Chapter 3 it was found that a specific characteristic, continuity of care, has a strong relation with healthcare consumption, expressed as the referral rate.

The second sub-question was explored in Chapters 4 to 6, in which patients were analyzed who underwent a total hip arthroplasty (THA). In Chapters 4 and 5 length of stay (LOS) after THA was used as primary measure of healthcare consumption. In Chapter 4, a systematic review of the literature, limited evidence was found for the relation between patient comorbidity and LOS as well as hospital costs for THA. Chapter 5 presents a study that found a strong association between medication use (a patient characteristic) and LOS after THA. Finally, in Chapter 6 it was found that patient comorbidity was not related to the actual workload of the nursing personnel on the orthopedic ward after THA. The perceived

workload however only partly correlated with the perceived workload of the nursing personnel.

In this General Discussion the following subjects will be examined. First the results and conclusions of the previous chapters, divided in two parts, will be discussed in the light of the general aim of this thesis and in relation to the literature. Second, other methods to measure healthcare consumption will be discussed. Finally, the generalizability of the results will be discussed, and future perspectives and future research questions will be presented. This general discussion will end with an overall conclusion.

PRIMARY CARE SECTOR

In this thesis the relation between several patient characteristics and healthcare consumption in the primary healthcare sector – defined here as the number of consultations/visits and the referral rate – was analyzed. Both demographic patient characteristics and characteristics related to patients' health proved to have a relation with healthcare consumption. Continuity of care, both a patient and provider characteristic, was also related to healthcare consumption. These characteristics could eventually be used as input for a differentiated capitation system, in which the capitation depends on patient characteristics, amongst other variables. In a first step to define characteristics for a differentiated capitation system in this thesis, older patients as opposed to younger patients, females as opposed to males, patients with comorbid illnesses as opposed to patients without comorbidities, and continuity of care (CoC) seem to be relevant to include.

An important prerequisite for patient characteristics to be used in a differentiated capitation system is that the characteristics be straightforward and easy to measure, otherwise too much effort has to be done to retrieve the data and a characteristic could provoke fraudulent reimbursement practices. The characteristics used in this thesis were all easily accessible and straightforward, and can thus be considered good potential candidates for the capitation model. On top of that, the data could eventually be retrieved from different data sources to prevent miscalculation. Besides the characteristics analyzed in this thesis, there are likely more characteristics associated with healthcare consumption in the primary health care sector. These characteristics could – when proven to have a sufficiently strong relation with healthcare consumption –be used as additional input for differentiated capitation. Additional characteristics that could have a relation with healthcare consumption could be categorized into patient characteristics and practice/provider characteristics. Besides age and sex, other patient characteristics such as social problems (e.g. unemployment) are related to the number of times patients visit their GP (Karlsson, Lehtinen & Joukamaa 1994, Smits et al. 2014). Living in a socially deprived area was not related to the consultation rate for patients in the Netherlands ((Flinterman LE, de Bakker DH & Verheij RA 2015). Given that studies present conflicting results, the relation between social problems and healthcare consumption in primary care still has to be further analyzed.

Another patient characteristic that can be considered for its relation with healthcare consumption is the number of medications used by the patient. This relation was already proven earlier in the UK, where patients who used more medications visited their GP more often than patients who did not use medication (Brilleman, Salisbury 2013). This characteristic is also less likely to be a subject of fraud, as it is unlikely that patients will receive medication for illnesses they do not have. The results from the UK however still need

to be reproduced in other studies, and the same applies for the Dutch situation before this characteristic can be considered an input for differentiated capitation.

Practice characteristics are characteristics that are not related to the individual patient but could be of influence on the individual patient's healthcare consumption. In the UK practice characteristics explained very little of the variation in hospital admission rates – a measure for healthcare consumption – both for emergency and elective admissions (Reid, Cook & Majeed 1999). On the other hand, in the UK smaller list size of the practice and greater distance from a hospital lowered hospital admissions (Bankart et al. 2011). On the provider/GP side, both demographic characteristics and personality of the GP may be of influence on the healthcare consumption of the patient. Age of the GP was found to be of influence on the consultation rate, with older GPs having lower consultations rates (Bolanos-Carmona et al. 2002). As measure for healthcare consumption, a low "tolerance of risk" of GPs was related to higher hospital referrals in out-of-hours services (Ingram et al. 2009). It can be concluded that the evidence for the relation between practice characteristics and healthcare consumption is not straightforward. Further research is needed that analyzes all (or at least different) practice characteristics in a Dutch setting before one can use (part of) them as input for differentiated capitation.

In addition to the characteristics analyzed in this thesis and the patient and practice/provider characteristics discussed above, other characteristics could also be of influence to health consumption in the primary care sector but are less applicable as input for a differentiated capitation as they are less reliable, are hard to measure, or – most importantly – have not proven to have a strong relation with healthcare consumption. It is for example questionable whether patients' self-reported health status reflects their health

better than objective health measures (such as an extraction from the electronic patient file). So far, studies have presented conflicting results (Baker, Stabile & Deri 2004, Perruccio, Katz & Losina 2012). Another characteristic is the personality and emotional condition of the patient, which could potentially influence consumption of health care in the primary care sector. Agitation, for example, was common in patients that used primary care in out-of-hours services (den Boer-Wolters et al. 2010). Other personality traits and beliefs (e.g. anxiety) still have to be studied for their relation with healthcare consumption. Studies that have proven the relation between personality traits and healthcare consumption are not yet available.

To summarize, in addition to the analyzed characteristics in this thesis – age, sex, comorbidity and continuity of care – other patient and practice/provider characteristics can be considered for their relation with healthcare consumption and eventually as a starting point for differentiated capitation. More research however is needed before this step can be taken.

Measuring healthcare consumption in primary care

The studies in this thesis have measured healthcare consumption in the primary care sector availing themselves of (i) the amount of contact between patients and GPs, (ii) costs in primary health care and (iii) referral rates to hospital care. Other measures could also be used to determine the healthcare consumption of patients, but are less applicable to future research. Two examples will be discussed here.

First, healthcare consumption could be defined as the actual time a GP or the GP's personnel spends on a patient. For example, the actual duration of consultations, visits, telephone

consultations and administrative tasks could be measured in order to give an accurate and clear presentation of the actual work that is done by the GP (or his/her staff). The problem with this measure is its feasibility, as this is a very time-consuming and expensive measurement to execute. This measure thus seems less applicable for further research.

Second, the perceived workload of GPs could be used as a measure for the health care consumption of patients in primary care. Those patients who ask a lot of the time and effort from the GP (and his/her staff) could also be the patients that consume the most healthcare resources in primary care. However, the perceived workload of GPs is a very subjective measure, which is influential and therefore subject to fraud. This seems to make perceived workload unsuitable for further research in terms of its relation with healthcare consumption.

HOSPITAL SECTOR

In the chapters of this thesis on the hospital sector several patient characteristics of total hip arthroplasty (THA) patients were presented that are related to healthcare consumption in the hospital. Both age and health-related characteristics – comorbidity and preoperative medication use – are related to length of hospital stay (LOS) after THA. Other authors have also studied which preoperative patient characteristics influence LOS after THA. In a systematic review strong evidence was found that comorbidity indexes and the presence of heart and lung disease was associated with longer LOS (Elings et al. 2014). The results presented in this thesis are in line with that systematic review. This thesis also showed that comorbidity indexes were related to the perceived workload of the orthopedic ward nursing staff that helped THA patients on their first postoperative day. LOS and workload were both

used as operationalizations of healthcare consumption at the hospital. These characteristics could eventually be used as input for differentiated capitation. However, other characteristics should also be considered for their relation with healthcare consumption as well as for their potential to be used as predictive characteristics for differentiated capitation.

As in the primary care setting, again an important condition for other characteristics to be used as potential input for differentiated capitation is that they be easy to measure and retrieve, and are not subject to the influence of physicians and/or other healthcare workers. Examples of characteristics that could be analyzed for their relation with healthcare consumption can be categorized into demographic patient characteristics, health-related characteristics, and practice and/or provider characteristics. These will be discussed in detail below.

Besides the studied demographic patient characteristic of age, other demographic patient characteristics could be taken into account. The influence of the sex of the patient still remains unclear (Olthof et al. 2016). Since this is an easy demographic characteristic to measure and complies with other stated criteria, the influence of sex could be further studied for its relation with healthcare consumption. Other demographic characteristics that are associated with the LOS after THA and could thus potentially be incorporated into differentiated capitation are patients' living situation (patients living alone have longer LOS than others) (den Hartog et al. 2015, Husted, Holm & Jacobsen 2008) and/or socioeconomic background (low SES was associated with longer LOS) (Inneh et al. 2015). After determining whether these characteristics have a sufficiently strong relation with healthcare

consumption, they could potentially be used as input for differentiated capitation as they are easy to measure, straightforward and easily applicable.

Examples of measures related to patients' health that could be used in a differentiated capitation model are body mass index (BMI) and frailty. A higher BMI has previously proven to be associated with longer LOS after THA by various authors (Inneh et al. 2015, Maradit Kremers et al. 2014, Kim 2010). BMI is easy to measure, but can be subject to fraud since its input can be influenced by the healthcare professional (e.g. whether the patient is dressed when weighed). Frailty is a measurement that not only incorporates patients' comorbidities but also their physical and mental state. Higher scores on frailty were associated with longer LOS after THA (McIsaac et al. 2016). However, the results of this study would first have to be reproduced by others to make it suitable as input for differentiated capitation. Secondly, the additional value above the comorbidity measure as previously presented in this thesis should be determined. There also needs to be consensus on how frailty is measured, since a wide range of measures is presently used in the academic world (Warnier et al. 2016, Buta et al. 2016).

Practice and/or provider characteristics could also be considered for their relation with healthcare consumption. An example of a characteristic from practice is the surgical technique for THA: some techniques can lead to shorter LOS than others (den Hartog et al. 2015, Yue, Kang & Pei 2015). An example of a provider characteristic is volume of THA per orthopedic surgeon, which was inversely associated with LOS (Styron et al. 2011, Paterson et al. 2010). Whether these characteristics could eventually be used for differentiated capitation is questionable, as they could potentially give the wrong financial motives for

healthcare providers and can be subject to the influence of many other factors (such as the experience of a surgeon with the operative technique).

To summarize, patient characteristics other than age, comorbidities and medication can have a relation with health consumption after THA. These characteristics could eventually be used as input for differentiated capitation, but many steps still have to be taken before this can be determined. Other characteristics should also be evaluated for their relation with healthcare consumption around THA and the potential to be incorporated into differentiated capitation.

Measuring healthcare consumption in the hospital sector

Healthcare consumption at the hospital can also be measured in various ways. In this thesis the choice was made to use length of hospital stay (LOS) and the workload of nursing personnel on the ward. LOS has as advantages that it is universally applicable and easy to measure, and gives a good impression of healthcare consumption, yet it can be too rough in its determination of healthcare consumption. Workload measurement can give a much more detailed representation of a patient's consumption of care. However, workload is very time-consuming to measure.

Besides LOS and workload, other methods can be used to measure healthcare consumption. The costs of THA have been used as outcome measure in several previous studies (McIsaac et al. 2016, Maradit Kremers et al. 2014, Nichols, Vose 2016, Tien et al. 2009). The rationale for costs is that it gives detailed information about the use of resources. When the price of a Diagnosis Treatment Combination (DBC) is used as THA cost, it is an easily accessible outcome measure. Using costs as measure for healthcare consumption also has a number of

disadvantages. First, costs are strongly related to the country where the study has taken place, making the results less generalizable ((Schreyögg et al. 2008). Second, it can be difficult to determine the actual costs that patients incur during a hospital admission for THA. This is due to the allocation of hospital overhead costs. Every institution has its own method of allocating these costs, for example as a percentage of the admission days or the amount of time of the surgery (Tan et al. 2009). Third, costs of THA can rise regardless of other health consumption measurements. For example, in the last decade LOS after THA has decreased, yet the costs of THA have increased significantly (Molloy et al. 2017). This may be due to differences in the population that gets THAs or to organizational and surgical choices. All these factors make the total costs of THA difficult to compare amongst hospitals and thus less applicable in practice, therefore LOS is still considered to be the best option to measure healthcare consumption for THA patients.

TOWARDS THE FUTURE

This thesis analyzed the relation between several patient characteristics and the consumption of health care of patients in the Netherlands. This part of the General Discussion explores future perspectives from here on. First, the generalizability of the results of this thesis will be discussed. Second, the steps that are required towards differentiated capitation will be presented.

Generalizability

The studies in Chapters 2 and 3 – the primary care sector – were conducted in the Northern part of the Netherlands with the aid of an electronic database that automatically generates data for approximately 30,000 patients from three general practices. As this data is often tested for its generalizability for the entire population of the Netherlands (Biermans et al. 2008), it is argued that the results found in Chapters 2 and 3 are generalizable to the whole Dutch primary care sector.

Whether the results from Chapters 2 and 3 are generalizable to other countries is questionable. The Dutch primary care sector differs from many other countries. Dutch patients are enrolled with a single GP practice, they often stay for long periods of time with their GP, and the GP has a gatekeeping role for the hospital care sector. GP-related habits, culture and consultation systems can also differ vastly. Dutch patients, for example, have on average 2.08 consultations with their GP (Olthof, Groenhof & Berger 2015), whereas patients in the UK have an average consultation rate of 4.3 (Brilleman, Salisbury 2013) per year. The vast differences between Dutch primary care and the primary care in other countries limits the generalizability of the results.

The studies for the hospital sector in this thesis – chapters 4 to 6 – the example of a THA was used. THA is characterized by being a very standardized procedure, with a clear indication and a measurable result. Since the THA protocol is comparable in many countries, the results of chapters 4 to 6 are reasonably generalizable to other countries with approximately the same protocol. However, generalizability of results to countries that differ greatly in LOS is questionable. For example, the average LOS after THA in Scandinavian countries is similar to

that of Dutch hospitals (Husted et al. 2010, Larsen, Hansen & Søballe 2008), yet Germany has longer average LOS after THA (15.2 days (Geissler et al. 2012)).

Whether the results from the hospital care sector chapters are generalizable to other DBCs remains unknown and should be the focus of future research, as no DBCs other than THA were analyzed in this thesis.

Future steps and perspectives

The studies in this thesis have provided a first step into analyzing the relation between patient characteristics and healthcare consumption. These characteristics could be used in the future as input for differentiated capitation, but there is still a long way ahead before a differentiated capitation model can be presented. This pathway is discussed below.

In addition to the characteristics analyzed in this thesis, other characteristics must be studied for their relation with healthcare consumption and for their applicability in a differentiated capitation model. These characteristics should also be tested for their mutual cohesion, to determine to what extent they influence each other and whether they individually add information to the explanation of variability of healthcare consumption. Negative side effects of differentiated capitation should be analyzed too. Examples are the influence of this financing model on the referral rate in primary care and its potential to deliberately adjust input characteristics to enlarge capitation reimbursement.

After determining which characteristics have a strong relation with healthcare consumption, these characteristics could be analyzed together on different large sets of patient data to test the predictive power of the model and its generalizability for the primary care sector

and THA procedures in the Netherlands. This analysis has to determine which part of the variability in healthcare consumption is explained by the input variables. Although there will always be some unexplained variability, it should be minimized as much as possible without adding too many variables to the model – as this would make the model too complex and the advantages in administrative burden would be rescinded.

After analyzing and testing many variables and the predictive power of different models, a differentiated capitation financing model for the Netherlands with reasonable explanatory power could be the ultimate outcome. However, as stated before, there is still a long way ahead and many challenges will be encountered along the way. On top of that one has to realize that a perfect model does not exist and that there will always be some unexplained variance. An example of unexplained variance is the “super-utilizing patient”. This is a small group of patients that continuously use large amounts of healthcare services (Emeche 2015, Lee et al. 2017, Pimlott 2016, Johnson et al. 2015). The composition of this group and their healthcare consumption pattern is very diverse (Lee et al. 2017, Ruger et al. 2004). Hence although the super-utilizers consume large amounts of health care, they are immune to being confined to or measured by a single characteristic and are therefore hard to incorporate into differentiated capitation.

In addition, the generalizability to DBCs other than THA in the Netherlands should be evaluated, to analyze whether differentiated capitation is suitable for the hospital sector as a whole. Finally, the generalizability of the differentiated capitation model to other countries could be tested. This however will entail much additional research before any statements can be given on whether differentiated capitation is applicable to foreign countries.

OVERALL CONCLUSION

A differentiated capitation system is a different way of financing health care – both in primary and in hospital care – which possibly justifies the healthcare consumption pattern of patients better than the current financing systems. In this thesis a set of patient characteristics and their relation to healthcare consumption in primary and hospital care (THA) was analyzed. First, the association of age, comorbidity measures and continuity of care with healthcare in primary care was demonstrated. Second, studies were presented that demonstrated associations of the patient characteristics age, comorbidity and medication use with length of stay after total hip arthroplasty – as measure for healthcare consumption. At last a study was presented that provided a first insight into patient characteristics that were associated with healthcare consumption on the ward after THA, measured as the workload of nursing personnel.

Together these characteristics could eventually make up the basis for a differentiated capitation system. On the way towards the development of a differentiated capitation system, additional research is needed to test the influence of other characteristics as well as the predictive power of the system and its generalizability. This differentiated capitation system could provide an alternative for the current financing systems, by improving reimbursement for the actual efforts and by reducing the administrative burden physicians are currently overwhelmed with. A properly-working differentiated capitation system could be the best option with the right financial stimuli for physicians and the best health care for patients.

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SUMMARY

INTRODUCTION

Different types of financing methods are used around the world, and all have advantages and disadvantages. Examples of financing methods are Fee For Service (FFS), capitation and salary payment. A differentiated capitation system provides a good alternative for these well-known financing systems. Although a differentiated capitation system provides one budget per patient per period of time, this budget is adjusted to specific characteristics of a patient. Characteristics that can be used to adjust the capitation budget could be demographic (e.g. age, sex, marital status), health-related (e.g. comorbid illnesses) or lifestyle-related (e.g. smoking status, fitness level).

The aim of this thesis is to enlarge the knowledge about differentiated capitation models. A starting point is to study which patient characteristics are usable in such models. These characteristics should enable differentiation between high and low healthcare consumption, given that the consumption of health care (i.e. the amount of care that a patient consumes during a period of time) is directly related to the budget needed to provide the care. In this thesis patient characteristics in both the primary healthcare sector and the hospital sector are analyzed for their association with healthcare consumption.

PRIMARY HEALTH CARE SECTOR

First, the relation between patient characteristics and healthcare consumption in the primary care sector was explored. In **Chapter 2**, healthcare consumption was defined as the number of consultations and visits patients have with their GP per year. Older patients, females and patients with multiple chronic comorbidities were found to have above-average

healthcare consumption. Especially patients with severe back complaints, asthma/COPD, depression and medically unexplained physical symptoms (MUPS) were found to be high users of primary care.

The relation between a specific patient characteristic, Continuity of Care (CoC) and healthcare consumption is presented in **Chapter 3**. CoC is the relationship between a GP and a patient that extends beyond a single episode of illness. In this study the rate of referral is used as a definition of healthcare consumption. The patients in this study that were only seen by their own GP during the two-year study period were almost 20% less likely to be referred to specialist care than patients who were also seen by other GPs. Specifically for pediatrics, the referral rate was higher when patients (and their parents) experienced low CoC. Patients' own GP was more likely to refer to gastroenterology, ophthalmology, psychiatry, dermatology and neurology.

HOSPITAL SECTOR

The second part of the thesis focuses on the hospital sector. It starts off in **Chapter 4** with a systematic review about the relation between patient characteristics and healthcare consumption after total hip arthroplasty (THA). Here length of hospital stay (LOS) and hospital costs were used as operationalization of the consumption of health care. The systematic review in Chapter 4 presents limited evidence that comorbidity indexes – in this study the American Society of Anesthesiologists (ASA) score and the Charlson Comorbidity Index (CCI) – are associated with longer LOS and hospital costs.

In addition to comorbidity indexes, previous literature has also presented studies that analyzed the association between number of medications and LOS. Higher preoperative medication use was related to longer LOS after different types of surgical procedures, but the effects of preoperative medication use solely on LOS of THA patients has never been studied specifically. A study that has analyzed the association between medication use prior to THA and LOS is presented in **Chapter 5**. Medication use was determined to be a stronger predictor of LOS after THA than age, sex, and two comorbidity indexes: the ASA classification and the Chronic Disease Scale (CDS).

Lastly, a study that analyzed the association between patient characteristics and healthcare consumption in the orthopedic ward after THA is presented in **Chapter 6**. The study defines healthcare consumption as the time that nursing personnel spend on patients and their perceived workload during the first postoperative day. It was hypothesized that patient characteristics related to longer LOS after THA are also predictors of the time and burden of the work of nursing personnel at the orthopedic ward, as is the case for the patient characteristic of comorbidity (or comorbidity index). However, this study found that the time spent by nursing personnel on THA patients postoperatively was not associated with any of the comorbidity indexes studied. The perceived workload of the nursing personnel was associated with two comorbidity indexes: ASA classification and CCI.

The thesis ends with a General Discussion in **Chapter 7**. Although several studies have been conducted to analyze the association between patient characteristics and healthcare consumption, there are still many uncertainties as to which characteristics are the best predictors and how the unknown variance can be minimized. To come to a differentiated capitation model, several patient characteristics should be analyzed together on a large data

set in order to test what part of the variance in healthcare consumption can be explained. There is a long way ahead and many obstacles to overcome, but the analyses presented in this thesis are among the first towards differentiated capitation.

NEDERLANDSE SAMENVATTING

INTRODUCTIE

De gezondheidszorg wordt internationaal op verschillende manieren gefinancierd. Elke financieringsmethode heeft voor- en nadelen. Voorbeelden van financieringsmethoden zijn Fee For Service (FFS), het abonnement systeem en het salarissysteem. Een gedifferentieerd abonnement systeem biedt een goed alternatief voor de bekende financieringsmethoden. Bij dit systeem ontvangt de zorgverlener één budget per patiënt per tijdsperiode zoals bij het abonnement systeem, maar dit budget is aangepast aan de kenmerken van de patiënt. Karakteristieken die gebruikt kunnen worden voor deze aanpassing kunnen zowel demografisch (bijv. leeftijd, geslacht en burgerlijke staat), gezondheid gerelateerd (bijv. de aanwezigheid van chronische ziekten) en lifestyle-gerelateerd (bijv. rookstatus, fitheid).

Het doel van dit proefschrift is om de kennis over gedifferentieerd abonnement systeem te vergroten. Allereerst is het hiervoor van belang om te bepalen welke patiënt kenmerken bruikbaar zijn voor dit systeem. Deze kenmerken moeten kunnen differentiëren tussen patiënten met een hoge en een lage zorg consumptie, gegeven dat de consumptie van zorg (dat wil zeggen de hoeveelheid zorg die een patiënt gebruikt tijdens een tijdsperiode) direct gerelateerd is aan het benodigde zorgbudget. In dit proefschrift wordt zowel de relatie tussen patiënt kenmerken met de zorgconsumptie in zowel de eerstelijnszorg als de tweedelijnszorg onderzocht.

EERSTELIJNSGEZONDHEIDSZORG

Allereerst is de relatie tussen patiëntkenmerken en zorgconsumptie in de eerstelijnsgezondheidszorg onderzocht. In **hoofdstuk 2** is de zorgconsumptie gedefinieerd

als het aantal consulten en visites per patiënt dat patiënten met hun huisarts hebben per jaar. Oudere patiënten, vrouwen en patiënten met meerdere chronische ziekten hadden een bovengemiddelde zorgconsumptie. In het bijzonder waren patiënten met ernstige rugklachten, astma/COPD, depressie en Somatisch Onverklaarde Lichamelijke Klachten (SOLK) grootgebruikers van eerstelijnszorg.

De relatie tussen een specifiek patiëntkenmerk, continuïteit van zorg (CoC), en zorgconsumptie wordt in **hoofdstuk 3** gepresenteerd. CoC is de relatie tussen een huisarts en een patiënt die verder strekt dan een enkele ziekte episode. In deze studie werd zorgconsumptie gedefinieerd als het verwijspercentage per patiënt naar tweedelijnszorg. Patiënten uit deze studie die enkel door hun eigen huisarts werden gezien gedurende de 2-jaar durende studieperiode bleken gemiddeld 20% minder verwezen te worden dan patiënten die ook andere huisartsen consulteerden. In het bijzonder bleek voor kindergeneeskunde het verwijspercentage hoger te zijn wanneer patiënten (en hun ouders) een lage CoC hadden. De eigen huisarts van patiënten verwees vaker naar de specialismen Maag-Darm-Lever (MDL) geneeskunde, oogheelkunde, psychiatrie, dermatologie en neurologie.

TWEEDELIJNSGEZONDHEIDSZORG

Het tweede deel van dit proefschrift focust op de gezondheidszorg in het ziekenhuis. In **hoofdstuk 4** wordt een systematische review gepresenteerd waarin de relatie tussen patiëntkenmerken (in deze studie comorbiditeitsindexen) en de zorgconsumptie na totale heup arthroplastiek (THA) is onderzocht. In deze review werd de ligduur van patiënten tijdens THA en de ziekenhuiskosten tijdens de opname als definitie van zorgconsumptie

gebruikt. In het onderzoek wordt beperkt bewijs gevonden dat hogere scores op twee comorbiditeitesindexen – te weten de American Society of Anesthesists (ASA) score en de Charlson Comorbidity Index (CCI) geassocieerd zijn met langere ligduur en hogere ziekenhuiskosten.

Naast onderzoek naar comorbditeitsindexen zijn er in de literatuur ook onderzoeken gepubliceerd die de relatie tussen ligduur van patiënten in het ziekenhuis en het aantal medicijnen van patiënten. Voor verschillende aandoeningen is deze relatie reeds onderzocht, echter nog niet voor THA patiënten. Een onderzoek dat deze relatie bestudeerd wordt gepresenteerd in **hoofdstuk 5**. Medicatiegebruik was in dit onderzoek de sterkste voorspeller van ligduur. Leeftijd, geslacht en twee comorbiditeitsindexen (de ASA score en de Chronic Disease Scale (CDS)) bleken de ligduur minder goed te kunnen voorspellen.

Als laatste wordt er in **hoofdstuk 6** een studie gepresenteerd die de relatie tussen patiëntkenmerken en zorgconsumptie op de verpleegafdeling van de orthopedie tijdens THA analyseert. In deze studie is de zorgconsumptie gedefinieerd als de tijdsduur die verplegend personeel spendeert aan patiënten op de eerste postoperatieve dag van THA patiënten. Daarnaast werd er gekeken naar de beleefde zorgzwaarte door de verpleging op deze eerste postoperatieve dag. De hypothese was dat patiëntkenmerken die geassocieerd zijn met langere ligduur ook voorspellend zijn voor de tijdsduur en de belasting van het verplegend personeel rondom de zorg voor THA patiënten. Echter de tijdsduur bleek geen relatie te hebben met de onderzochte patiëntkenmerken. De beleefde zorgzwaarte was wel geassocieerd met twee comorbiditeitsindexen (ASA score en CCI).

In **hoofdstuk 7** worden de voorgaande hoofdstukken in een breder perspectief geplaatst. In de verschillende studies zijn associaties tussen patiëntkenmerken en zorgconsumptie

gevonden. Echter er zijn nog vele onzekerheden met betrekking tot welke patiëntkenmerken de zorgconsumptie het beste voorspellen en hoe onverklaarde variantie kan worden geminimaliseerd. Om tot een gedifferentieerd abonnement systeem te komen moeten verschillende patiëntkenmerken nog gezamenlijk in een model geanalyseerd worden in een grote dataset om te onderzoeken in hoeverre de zorgconsumptie verklaard kan worden. Er is nog een lange weg te gaan om tot een gedifferentieerd abonnement systeem te komen en er zijn nog vele uitdagingen te tackelen, maar de eerste stappen in de goede richting zijn gepresenteerd in dit proefschrift.

DANKWOORD

DANKWOORD

“It takes a village to raise a child” en dat geldt ook voor het schrijven van een proefschrift. Vele mensen hebben bijgedragen en mij ondersteund tijdens dit proces van de afgelopen 6 jaren. Een aantal personen wil ik in het bijzonder bedanken.

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CURRICULUM VITAE

LIST OF PUBLICATIONS

CURRICULUM VITAE

Marijke Olthof is geboren op 4 oktober 1985 in Zwaagwesteinde. Na de basisschool volgde zij het Atheneum aan het Lauwers College te Buitenpost. In 2003 startte zij de studie Geneeskunde aan de Rijks Universiteit te Groningen. In 2005 begon zij daarnaast met de studie Business Administration (Bedrijfskunde). Tijdens haar studies was Olthof actief in vele onderwijscommissies als studentenvertegenwoordiger, waaronder als studentadviseur van het managementteam onderwijs van de studie geneeskunde in 2005-2006. Ook was zij wetenschappelijk actief bij de Junior Scientific Masterclass. In 2010 behaalde zij haar Master diploma's voor zowel Geneeskunde als voor Business Administration (afstudeerrichting Change Management).

Aansluitend begon Olthof in 2010 met de huisartsopleiding te Groningen, alwaar zij ook deelnam in de AIOS-vertegenwoordiging als voorzitter van de regionale AIOS vereniging. Ook was zij actief binnen de landelijke AIOS vereniging. In 2011 startte Olthof haar promotietraject bij prof. dr. S.K. Bulstra en prof. dr. M.Y. Berger. Na afronding van de huisartsopleiding in 2013 werkte Olthof als waarnemend huisarts in verschillende huisartspraktijken in Groningen en Drenthe. Na afronding van haar proefschrift gaat Olthof zich richten op het praktijkhouderschap. Marijke Olthof is getrouwd met Bram Bessem, samen hebben zij 3 kinderen.

LIST OF PUBLICATIONS

Olthof M, Stevens M, Dijkstra B, Bulstra SK, van den Akker-Scheek I. Actual and perceived nursing workload and the complexity of patients with total hip arthroplasty. Accepted pending revision in Applied Nursing Research.

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